



## COUNTRY STUDIES

# Denmark - Regulatory Reform in Electricity 1999

### Introduction

The Review is one of a series of country reports carried out under the OECD's Regulatory Reform Programme, in response to the 1997 mandate by OECD Ministers. This report on regulatory reform in electricity in Denmark was principally prepared for the OECD by Mr. Carlos Ocana with the participation of Ms. Sally Van Sichen.

### Overview

### Related Topics

## **BACKGROUND REPORT ON**

### **REGULATORY REFORM IN THE ELECTRICITY INDUSTRY\***

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## TABLE OF CONTENTS

1. FEATURES OF THE ELECTRICITY SECTOR IN DENMARK
  - 1.1 Key features
  - 1.2 Historical context
  - 1.3. Policy objectives
  - 1.4. Performance
2. STRUCTURE
  - 2.1. Elsam and Elkraft
  - 2.2. Generation
  - 2.3. Transmission
  - 2.4. International trade
  - 2.5. Natural gas
  - 2.6. District heating
  - 2.7. Ownership
3. REGULATORY FRAMEWORK
  - 3.1. Institutions
  - 3.2. Instruments
  - 3.3. Economic regulation until the 1999 Reform
  - 3.4. Taxes and subsidies
  - 3.6. Environmental regulation
4. THE 1999 REFORM
  - 4.1 Main Elements of the Electricity Reform
  - 4.2 Critique of the reform
5. CONCLUSIONS AND RECOMMENDATIONS
  - 5.1. Conclusions
  - 5.2 Recommendations

## **Tables**

1. Danish energy plans and important energy acts
2. Environmental objectives
3. Emissions per unit of GDP
4. Structure of generation in Western Denmark
5. Structure of generation in Eastern Denmark
6. Electricity transmission to other countries
7. Trade in Nordic Countries 1997 (Gwh)
8. Production and use of district heating 1996
9. NESA A/S electricity sales, duties and indirect taxes
- 10: Liberalisation of Retail Supply
- 11: Electricity entities under the 1999 reform

## **Figures**

1. Industrial electricity prices in selected OECD countries 1997
2. Domestic electricity prices in selected OECD countries 1997
3. NordPool spot prices 21 July - 31 Oct. 99: system price vs. Jutland/Funen area price

## **Executive Summary**

### **Background Report on Regulatory Reform in the Electricity Industry**

Denmark has engaged the reform of its electricity sector. This report commends the decision to reform but underlines that additional measures are needed for reform to succeed. Key priorities include further reducing the barriers to international trade, considering additional measures to improve the vertical structure of the industry, reinforcing independent regulation, increasing the incentives for efficiency in the regulation, and developing more market-based mechanisms for environmental policy. If these issues are adequately addressed, the benefits of reform for the Danish economy will be substantial.

The Danish electricity sector is vertically integrated and comprises about one hundred utilities, mostly co-operatives or municipally owned, further grouped into two partnerships, Elsam and Elkraft, that control generation, import and export electricity, and plan generation and transmission expansions. Historically, the industry has been run on a non-for-profit basis to a large extent. The pattern of diffuse ownership has raised issues of stranded assets that have had the effect of slowing reform. Much electricity and heat are jointly produced, so non-distorting policies must be designed jointly for both sectors. Denmark's location on the "hydro-thermal" border means there are large gains from international trade, with the concurrent requirement to have an internationally compatible regulatory system. The sector's present form results from several earlier policies. In the 1970s, the primary fuel shifted from oil to coal as a response to the Oil Crises. Subsequent changes in perception of the environmental effects of generation caused increased use of CHP, shifts from coal to gas, and onward toward renewables including wind-power". The implementation of the European Union Directive on the Common Market in Electricity and the extensive trade with more liberalised Norway and Sweden are promoting further policy shifts.

The basic lines of reform were adopted by the Danish Parliament in May 1999 but some major operational issues have yet to be resolved. According to the 1999 regulations, end-user choice of supplier will be introduced on an accelerated schedule so that all end-users will have supplier choice from the end of 2002. There will be corporate unbundling of production, transmission, system operation, distribution, and trade (retail supply). Although some structural changes will take place, the ownership of the existing assets remain basically unchanged. Economic regulation is changed so that independent generating companies and trading companies may seek, and keep, profits, and compete. Monopolistic activities (transmission, distribution, system operation and regulated end user supply) will be regulated. A form of benchmarking will be introduced for transmission and distribution activities and there will be cost-based regulation for system operation and generation that is vertically integrated with monopolistic activities. Generators are assigned CO<sub>2</sub> quotas tradable in Denmark, which in the future might become internationally tradable. A market for Renewable Energy (RE) is expected to be set up in 2003 with RE generators being assigned RE certificates and end-users being obliged to purchase certificates in proportion to their electricity consumption.

The introduction of full consumer choice and the liberalisation of production and trade signal tremendous change in the regulation of the industry and will bring substantial gains to end users. If the Danish electricity sector were reformed in line with reforms in other Nordic countries, economic efficiency in the electricity sector could increase by at least 20 %. To achieve these gains stronger reforms are needed in some areas. First, corporate unbundling will increase transparency but falls short of changing the vertically integrated structure of the industry. Divestiture of generation from transmission and supply would eliminate incentives for monopolies to discriminate in favour of higher-cost generation with the same owners, thus reducing regulatory oversight and making it easier to ensure compliance with the legal requirements to provide non discriminatory access to the grid and for monopoly suppliers to procure least-cost power for their consumers. Second, there will be an independent regulator responsible for the economic regulation of the monopolistic activities. To carry out this task efficiently, the Energy Supervisory Board will need significant additional resources and independence relative to those that were needed in the past. Third, high regulatory barriers to entry into generation may persist thus distorting competition. The ongoing introduction of market-based mechanisms for environmental policy provides an opportunity to reduce regulatory barriers to entry.

Denmark can reap additional substantial rewards from reforming its electricity system in tandem with its Nordic and continental neighbours. Reforms in 1998 and 1999 have already resulted in significant changes in the organisational structure, and significant price reductions in the wholesale market in the western part of the country, which was integrated into the NordPool electricity market. Increased integration in the Nordic electricity market will result in cost-efficiency gains that would not be achievable in isolation given the small size of the Danish electricity systems. Increased integration is also likely to provide lower prices as prices converge to some intermediate level between the relatively low prices in Norway and Sweden and the higher prices in Germany. Furthermore, these gains can be obtained quickly and at low cost given both the strong physical links with neighbouring countries and the fact that Denmark is situated on the borderline between relatively cheap large scale hydro power in Norway and Sweden and relatively expensive thermal power in Germany. The single most important obstacle to the effective integration of the Danish market in the region consists of a number of agreements and cross-ownership between the Danish companies and foreign companies that may block transmission capacity and result in asymmetric transmission access. Some progress was made in 1999 regarding the allocation of available interconnector capacity but the issue of pre-existing agreements and rights persists. Even if there is no easy solution, options to deal with this issue need to be considered.

The strong environmental commitments of the Danish government offer challenges to reform. A key challenge is to increase the cost effectiveness of environmental policy and this requires the introduction of more market-based mechanisms to implement environmental policy, as well as the development of mechanisms to integrate environmental policy within the region. The new legislation contains some important building blocks for a more market oriented approach to environmental policy. There will be a Renewable Energy certificates market and tradable CO<sub>2</sub> emission quotas. However, most existing policies may remain unchanged. The ongoing reform provides the opportunity for Denmark to modernise and consolidate its environmental policy just ahead of the incipient move towards more market based environmental policies in the EU and elsewhere. In addition, the sustainability of Denmark's environmental goals without a further harmonisation of objectives with those of other countries should be reassessed to ensure that the environmental benefits outweigh the economic costs. Also, the efforts being made by the Danish government to promote increased international co-ordination and harmonisation of environmental policies should be maintained.

The recommendations of this study pursue five complementary goals and together form a comprehensive package that would produce substantial benefits. These goals are: create conditions for effective competition, protect consumers and ensure that consumers reap the benefits of reform, reinforce independent regulation, increase the cost effectiveness of environmental policies, and review the effectiveness of reforms. The main recommendations are summarised as follows:

*Create conditions for effective competition*

**Vertical Separation:** Reinforce vertical separation along the electricity supply chain, particularly as regards generation. Separate ownership of generation from transmission and from retail supply, and from system operation should be encouraged; and, in addition, requiring ownership separation of generation should be considered.

**Transmission:** Develop a methodology and set cost reflective tariffs and terms of access that do not discriminate between suppliers and are not distorted by the fragmented ownership of the transmission grids.

**Trade:** Ensure efficient and non-discriminatory access to international transmission links. In particular, consider options to eliminate the anticompetitive effects of agreements and cross-ownership between the Danish generators and foreign generators. Consider the viability of developing transmission links across the Great Belt to connect the Eltra and Elkraft areas thus making it possible for generation in one half of Denmark to supply customers in the other half.

**Competition law:** The application of competition law to the electricity supply industry has to be strengthened to prevent collusion, abuse of dominance, or anticompetitive agreements, mergers, and long-term contracts that risk frustrating reform.

**Stranded Costs and benefits:** Develop a comprehensive plan to resolve stranded costs and stranded benefits that is transparent and equitable, and does not hinder entry or subsequent competition.

*Protect consumers and ensure that consumers reap the benefits of reform*

**End user tariffs:** Ensure that end-user tariffs are cost reflective. In particular, set tariffs so as not to discriminate between customers remaining on regulated tariffs or opting to use the market, avoid artificially reducing the incentives of consumers to switch to the market, and apply homogeneous criteria across the different distribution areas.

**Small consumers:** Accelerate, as planned, end-user choice of supplier and consider measures to ensure that all electricity consumers have effective choice.

**Supply obligation companies:** Identify options to promote cost efficiency in the near term such as requiring supply obligation companies to buy electricity at the lowest available price and repealing provisions requiring grid companies to buy from their own production companies.

**Governance:** Identify options and provide consumer co-operatives and municipally owned electricity companies with governance structures that ensure that decisions are based on commercial criteria. Provide an accounting system that makes their objectives and achievements more transparent.

**Costs of monopolistic activities:** Introduce, as planned, regulatory incentives for cost reduction, such as price caps or yardstick competition, and monitor to ensure that the incentives are effective.

*Reinforce independent regulation*

**Energy Supervisory Board:** Reinforce the authority and independence of the Energy Supervisory Board, as well as the transparency of its decisions. Close relations between the competition authority and the new sector regulator should be encouraged. Increase, as planned, vigilance over the “necessary costs” of supply obligation, grid and transmission companies and ensure that the Energy Supervisory Board has enough resources to carry out this task.

*Increase the cost effectiveness of environmental policies*

**RE certificates:** Proceed as planned with the establishment of a “renewable energy certificates market”, consider designs that do not discriminate among technologies and work with trading partners to encourage the development of an international market.

**CO<sub>2</sub> emissions:** Encourage trading partners to develop an international market for controlling emissions of CO<sub>2</sub> to ensure that emissions control is achieved in the most efficient way.

**Other policies:** Review existing environmental policies to identify areas in which: market-based mechanisms could be introduced; redundancies exist so that policies can be consolidated; or rules (*e.g.* for granting tax breaks and subsidies) could be made more transparent and verifiable so that the effectiveness of policies is increased.

*Review the effectiveness of reform*

**Overall review of reform:** Review the reform some time (*e.g.* two to three years) after its implementation to judge its effectiveness, with particular reference to: the achievement of effective competition, the effectiveness of the new regulatory system and the effectiveness of environmental policies.

## 1. FEATURES OF THE ELECTRICITY SECTOR IN DENMARK

### 1.1. *Key features*

**Environmental policies shape the sector.** Danish per capita emissions of CO<sub>2</sub>, the main greenhouse gas, are among the highest in the world.<sup>1</sup> The Danish government has taken strenuous steps to reduce these emissions and has set ambitious targets for their reduction. To meet these targets, the electric companies are required to purchase, at prices higher than their avoided cost, electricity generated from wind, biomass, and small-scale combined heat-and-power (CHP) plants fuelled by biomass or natural gas. “Public service obligation” generation constitutes about 40% of the total production in Jutland and 17% on Zealand. Electricity companies are required to invest in biomass, on- and offshore wind generation, and research and development for energy efficiency. Fuel choice for CHP and generating plants is restricted. In addition, taxes, tax rebates, and subsidies are used to influence fuel choices and promote energy-saving investment by end-users.

**Located on the hydro-thermal border, there is much international trade.** Norway and Sweden have hydropower-based electricity systems (99% and about 50%, respectively) whereas Denmark and the countries to the south have thermal-based systems. This difference means there are large gains from international trade in electricity. Variations in the hydrological situation in Norway and Sweden cause Denmark’s trade in electricity to swing between large imports and large exports. In 1996, a very dry year, Denmark’s exports equalled almost 50%<sup>2</sup> of its domestic consumption; in 1989, a very wet year, Denmark’s imports equalled 34%<sup>3</sup> of its domestic supply. On average, Denmark imports power from Norway and Sweden and exports to Germany.

**The sector is dominated by two vertically integrated groups.** Elsam and Elkraft control generation, import and export electricity, and plan generation and transmission expansions. They own and operate (or have identical owners as the entity that owns and operates) the 400 kV transmission network and the system operators. Elsam operates in western Denmark, *i.e.*, Jutland and the island of Funen, and Elkraft operates in eastern Denmark, *i.e.*, the island of Zealand and nearby islands. Less than 25% of electricity is generated in plants not controlled by Elsam or Elkraft, and that is non-dispatchable wind or decentralised CHP. Regional groupings of local distribution companies own generating companies. The generating companies in the two areas form, respectively, the Elsam partnership and the Elkraft limited liability co-operative. The distribution companies also own the sub-400 kV networks.

**The sector is ultimately owned by about one hundred municipalities and consumer co-operatives.** The electricity sector is in diffuse ownership. Municipalities and consumer co-operatives own the local distribution companies. The boards of directors of the local distribution companies, as well as the boards of Elsam and Elkraft, have significant representation of local and regional politicians. The scope of ownership rights is, however, limited by restrictions on the use of the funds generated and the disposal of the assets.

**Generation is predominantly coal-fired, but shifting towards gas and wind.** About 78% of electricity in 1995 and 1996 was generated by coal, 14% by oil and gas and 5% by wind. The large, central generation plants are almost exclusively coal-fired. The Government is committed to eliminating coal generation after 2030. New coal-fired generation was banned in 1997; nuclear power was rejected by Parliament in 1985. Gas-fired CHP and wind-power are, with government support, gaining increasing shares of generation. In 1996, 48% of generated electricity was produced as CHP.<sup>4</sup>



Newly established economic regulation allows limited profits, but only those arising from efficiency improvements in monopoly segments. System operation, transmission and distribution are regulated so that expected revenue equals expected cost of efficient operation, including reasonable return on capital. Cost savings exceeding expectations attributed to the two latter activities may, at the decision of the regulator, be disposed of freely. Independent generation is not subject to economic regulation. Generation owned by grid companies, however, must apply any revenues exceeding costs, including cost of capital, to transmission or distribution activities. Supply to captive consumers is regulated. The economic regulation formerly applied to the sector, which allowed provision for a large fraction of future capital expenditures, has left the sector with very little debt, estimated at DKK5-10 million.<sup>5</sup>

**Average prices vary greatly from one distribution company to another.** In 1997, highest prices charged households were 50% higher than lowest prices, and the range of prices for larger consumers was even greater.<sup>6</sup>

**Gas is supplied by a heavily indebted monopoly.** State-owned Dangas (Dansk Naturgas A/S) is the monopoly, albeit not legal monopoly, for import, and is the legal monopoly for transport, storage, and trading of natural gas in Denmark. Regional monopolies distribute and supply gas. They have an agreement not to compete with one another. Gas is distributed through an extensive pipeline network. The capital cost of the network has not been paid, and free market prices of gas would be insufficient to pay this debt. Hence, the price of gas is regulated, and the level is set above free market levels to provide sufficient revenues to pay the capital costs of the network.

**District heating, which is jointly produced with electricity, is regulated so as not to compete with gas.** 80% of electricity is produced jointly with district heating; 75% of district heating is produced jointly with electricity.<sup>7</sup> New electricity generators must enter as CHP. District heating is installed throughout urban areas and the gas distribution system is installed throughout rural areas in a pattern that makes switching from district heating to gas infeasible. Competition from gas is further diminished by mandating connection to district heating networks in urban areas.

**Security of supply** concerns are addressed through domestic gas production and greater integration with other countries' energy markets. Two decades ago, Denmark reduced its dependence on imported oil by developing North Sea gas and oil fields and requiring central electricity generating plants to switch from oil to coal. More recently, the development of gas-fired CHP and of wind generation further decreases the country's dependence on imported energy.

**There is already some competition for large end-users but it is limited by constraints on transmission capacity.** End-users that consume at a single site, distribution companies that supply, or generators that produce, more than 100 GWh annually may contract directly with domestic or foreign generators. End-users cannot form co-operatives in order to meet the minimum. In effect, nine end-users and almost all distribution companies have direct access to the electricity market. Under current proposals, the 100 GWh minimum would decline to zero at the end of 2002. While there are large transmission connections to Norway, Sweden, and Germany, some of these capacities are reserved for pre-existing long-term supply contracts. Elsam and Elkraft are not directly connected, *i.e.* there is no transmission line across the Great Belt linking their regions. Hence, when prices in the two parts of Denmark diverge (because of congestion), generation located in western Denmark does not serve customers located in eastern Denmark, and vice versa, although both could serve, and thus compete for, customers located in Sweden. However, when there is no congestion, generators throughout the NordPool region compete with one another.

## 1.2. *Historical context*

The present form and regulation of the Danish electricity sector reflect recent economic and political history. Until the first Oil Crisis in 1973, there was no economic regulation of the energy sector. Responding to the Oil Crises in the 1970s, the Government developed its first energy policy with the overriding objective to reduce dependency on imported oil. In 1973, 90% of Danish energy consumed came from oil. Under the new policy, generation changed from oil to coal. The extent and speed of the changeover was extraordinary: from 1973 to 1979, the percentage of electricity generated from oil declined from 64% to 37%, and then to 5% in 1983. The decision was also taken, at the time, to use gas primarily for space heating, and to assign geographic areas to be served by gas or by district heating, but not both. Thus, the decision was taken to build an extensive gas pipeline network in rural areas and to extend the district heating networks in urban areas.

Emissions of noxious pollutants and greenhouse gases, mainly CO<sub>2</sub>, became of greater concern in the late 1980s. Thus, Government policy promoted a shift from coal to natural gas and the greater use of CHP. Under a 1986 political agreement between Government and utilities, 450 MW of small-scale CHP based on indigenous fuels would be built. The goal was not fully achieved (Danish Energy Agency, 199). The 1990 energy plan, *Energy 2000*, set out CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> emissions reductions targets for 2005, and a plan for energy savings, increased use of CHP and cleaner fuels, and research and development. Under a 1990 Parliamentary agreement, all small- and medium-sized district heating plants would convert to CHP or biomass by 1998.<sup>8</sup> *Energy 2000* recognised the need to ensure “a reliable, efficient and economical supply of energy.” The plan said that high energy prices were important for promoting energy conservation, and the Government accordingly reformed energy taxes. The energy taxes were borne primarily by households, since VAT-paying businesses were exempt.

*Energy 21*, the next and most recent (1996) major energy policy statement, is yet more tightly focused on reducing CO<sub>2</sub> emissions.

In parallel with domestic changes, the European Union directive on the internal market in electricity<sup>9</sup> reflects and prompts change across Europe. This directive provides several options for how a Member State may organise international trade in electricity, while also constraining some aspects of domestic regulation. In particular, provisions related to system operator independence, transmission access, and minimum size of liberalised consumers, prompted change in Denmark.

Liberalisation of the Norwegian and Swedish electricity sectors during the 1990s has also influenced discussions in Denmark. Norway allowed all end-users to choose electricity supplier in 1991, although high switching costs effectively excluded households from the market until 1995. Generation and transmission were put into separate divisions of vertically integrated firms, except that transmission was corporately separated from the largest generator, Statkraft. Generation is fairly unconcentrated by the standards of the sector: Statkraft has about a 30% share and there are about 70 other generators. Grids are regulated as “common carriers;” revenues cannot exceed costs, including return on capital. In Sweden, like in Norway, end-users gained the legal ability to change electricity supplier years before switching costs were sufficiently low for smaller consumers to exercise this ability; the relevant dates are July 1996 and (expected) 1 November 1999, respectively. Vertical integration in the sector is significant and increasing. The high concentration of generation in Sweden is only somewhat improved by imports of electricity from Norway. These Scandinavian liberalisation experiences are seen in Denmark as demonstrating the size of efficiency savings that can be found when end-users are granted choice of supplier.

Table 1. Danish energy plans and important energy acts

Year	Act or Plan	Main purpose or objective
1976	Electricity Supply Act	Governs the development and structure of the electricity sector.
1976	Danish Energy Policy 1976	Security of supply, energy savings, oil substitution.
1979	Natural Gas Supply Act (called elsewhere Construction of the Natural Gas Project Act)	Governs the development of the natural gas network.
1979	Heat Supply Act	Governs the development of the district heat sector
1981	Energy Plan 1981	Security at lowest cost through substitution of imported fuels: convert large power plants from oil to gas, more CHP, gas, and renewables.
1990	Energy 2000	CO <sub>2</sub> , SO <sub>2</sub> and NO <sub>x</sub> -reduction target for 2005, promotion of renewable energy and CHP, global environmental initiatives, energy savings.
1990	Heat Supply Act (Amended)	Framework for converting district heat to CHP, and heat pricing (Danish Energy Agency, 1998).
1992	Carbon Tax legislation	Detailed tax scheme, investment subsidies to energy efficiency measures, subsidies to CHP and renewable energies.
1996	Energy 21	Targets for CO <sub>2</sub> -reductions for 2005 and 2030, further promotion of CHP and renewable energy.
1996	Electricity Supply Act (Amended)	Came into force 1 January 1998. Governs structure and economic regulation of the electricity sector, “with a particular aim to promote the environmentally benign utilisation of energy.”
1999	Energy Supply Act	Adopted on 24 May 1999 but not yet implemented. Introduces competition into production and trade while maintaining the objectives of the 1996 Electricity Supply Act.

### 1.3. Policy objectives

The primary objectives of Danish energy policy, set out in *Energy 21* and ratified in the 1999 Energy Supply Act, are to deliver energy to Danish users efficiently, with minimum impact on the environment, while ensuring long-term energy self-sufficiency. Other objectives include maintaining the structure of local ownership of the electricity grids and system operation, and promoting export of and employment in energy-related technology, such as for wind turbines and clean coal technologies.<sup>10</sup>

The priority objective for Danish energy policy in the 1990s is environmental protection. Indeed, some commentators say that, “Economic efficiency is considered a restriction, *i.e.*, given a target ... those measures that will cause the least costs should be applied.”<sup>11</sup> This is in contrast to a social welfare approach where the value of environmental protection is estimated, and those measures that cost less than that value are applied. Under the former approach, but not under the latter, measures that cost more than the value of their environmental benefits can be applied.

The Government has established targets for CO<sub>2</sub> emissions, the share of renewable energy in total energy usage, and the ratio of energy usage to GDP. These targets are pursued through switching fuels, increasing energy efficiency, and promoting these objectives internationally. *Energy 21* foresees no coal-fired generation in Denmark by 2030. Given the Parliamentary rejection of nuclear power, present electricity policy is to shift toward gas-fired CHP, wind-power, and biomass-fuelled CHP.

Table 2. **Environmental objectives**

<b>Objective</b>	<b>Quantitative Measure</b>	<b>Date</b>
National CO <sub>2</sub> emissions	20% reduction from 1988	2005
	50% reduction from 1988	2030
<b>Sub-objective</b>	<b>Quantitative Measure</b>	<b>Date</b>
Transport CO <sub>2</sub> emissions	0% change since 1988	2005
	25% reduction from 1988	2030
Share of renewable energy in total energy consumption*	Approx. 12-14%	2005
	Approx. 35%	2030
Energy intensity (ratio of gross energy consumption to GDP)	20% improvement from 1994	2005
	55% improvement from 1994	2030

\* In 1996, this share was 8%.

Source: Danish Energy Agency, [HTTP://www.ens.dk/uk/about.htm](http://www.ens.dk/uk/about.htm) 11 Jan 1999.

Several policies promote energy self-sufficiency. Policies to increase the fraction of primary energy resources under Danish ownership include the development of Danish gas and oil resources, reduced oil usage (almost all oil used in Denmark is imported), and the development of wind generation. Policies to promote self-sufficiency in the conversion of primary fuels into electric power is pursued by a provision in the Electricity Supply Act that empowers the Minister for Environment and Energy to require utilities to maintain a minimum generation capacity in Denmark. Policies to diversify imported energy sources include purchasing coal from a large number of countries, having power stations able to burn a wide range of coal qualities, and increased international trade in gas and electricity.<sup>12</sup>

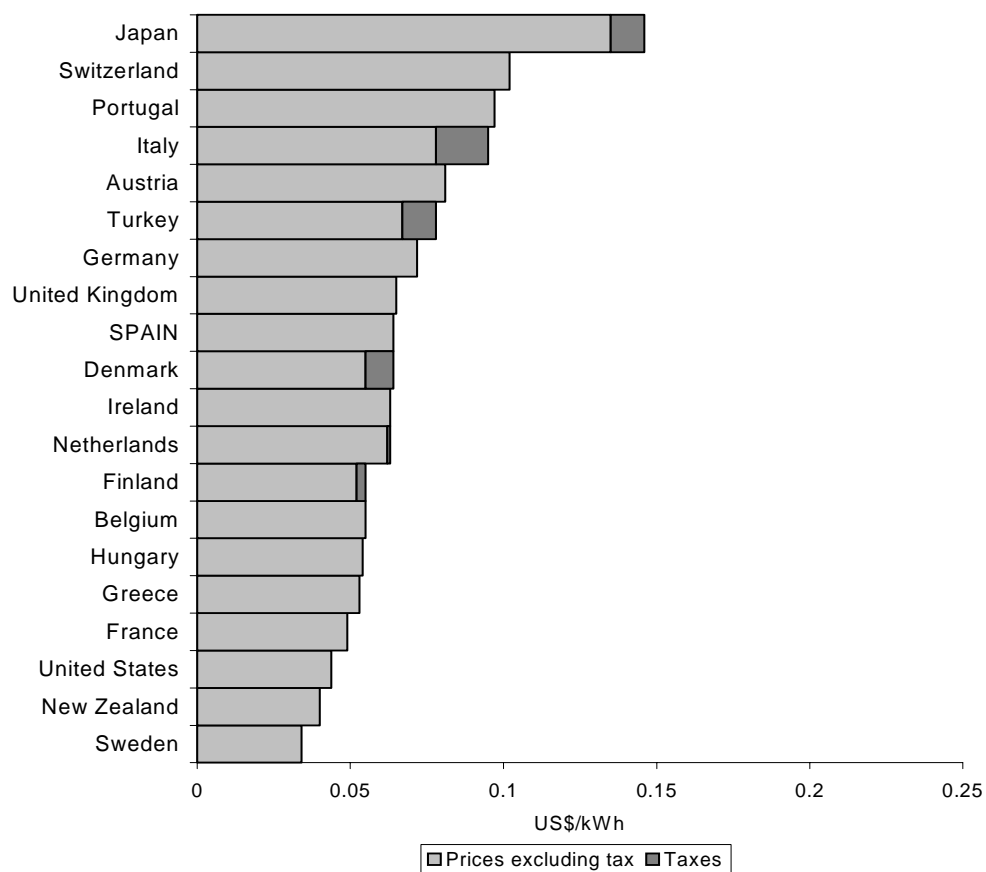
#### **1.4. Performance**

##### *Prices*

The price of electricity in Denmark, before taxes, is relatively low. Before-tax prices for both for households and industry are lower in Denmark than the median for OECD countries, as well as for OECD-Europe countries. However, they are higher than the prices for other Nordic countries. For example, the before-tax price of electricity sold to industry was 40 to 60% higher in Denmark than in Sweden (1996 and 1997 respectively), and 1 to 15% higher in Denmark than in Finland (1996 and 1997, respectively). The data for Norwegian sales to industry are unavailable. Price comparisons may be distorted by the way in which investments are financed in Denmark, since a large share of the costs of financing the investments is directly supported by end-users and is not included in the price of electricity.

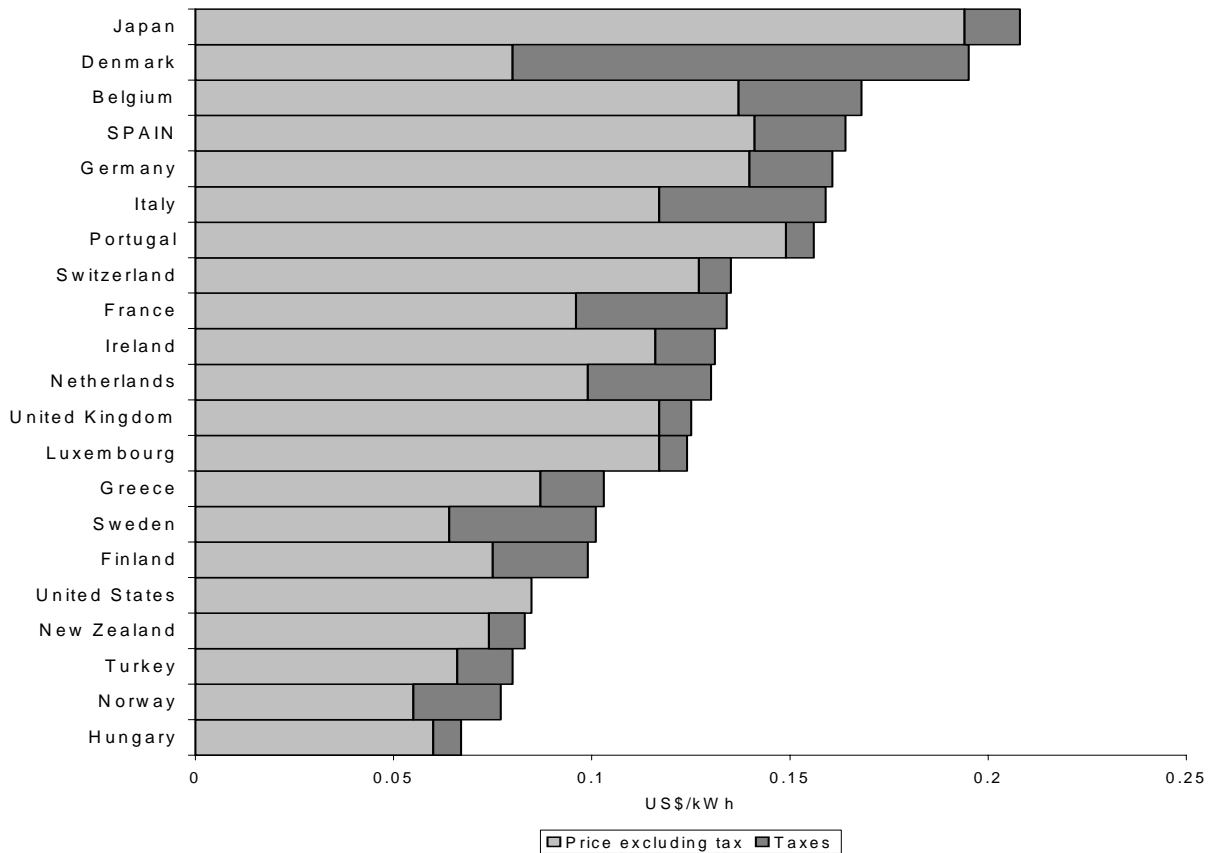
The after-tax price of electricity sold to households in Denmark is very high, exceeded, among OECD countries, only by prices in Japan. Denmark's after-tax price of electricity sold to industry is the ninth highest in the OECD. It is much higher than in Sweden (63% higher in 1996, 88% higher in 1997) and comparable to, but somewhat higher than, in Finland (1% and 14% higher in 1996 and 1997, respectively).

Figure 1. Industrial Electricity Prices in Selected OECD Countries 1997



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998

Figure 2. Domestic electricity prices in selected OECD countries 1997



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 1998.

*Reliability and security*

The Danish electricity sector has a high level of energy security. Coal, the primary fuel for electricity generation, is imported from a wide variety of countries. Until 1996, more than one-third was from other OECD countries. In 1997-8 this figure was reduced to 12-13%. The quantity of Norwegian and Swedish hydropower has been shown to be very variable, but the Danish electricity sector has proven robust to these disruptions. Similarly, the sector has shown its robustness with respect to variability in the output of Danish wind turbines, even sourcing backup power from abroad.

*Environmental performance*

The high reliance on burning coal to generate electricity causes high emissions of CO<sub>2</sub> and NO<sub>x</sub> per unit of GDP in Denmark, compared with other OECD-Europe countries. Compared with the average of the OECD as a whole, however, CO<sub>2</sub> and NO<sub>x</sub> emissions per unit GDP are only slightly higher. Emissions of SO<sub>x</sub> are much lower than average for both OECD-Europe and for the OECD as a whole. The high reliance on coal-fired generation combines with large swings between importing and exporting electricity to produce large swings in quantities of emissions from Danish power generators. These swings can make year-on-year comparisons misleading.

Table 3. Emissions per unit of GDP

Emission	SO <sub>x</sub>	NO <sub>x</sub>	CO <sub>2</sub>
Denmark	1.4 kg/USD1000	2.5 kg/USD1000	0.68 tonne/USD1000
OECD-Europe	2.3 kg/USD1000	2.0 kg/USD1000	0.55 tonne/USD1000
OECD	2.4 kg/USD1000	2.4 kg/USD1000	0.65 tonne/USD1000

Data from 1995 for SO<sub>x</sub> and NO<sub>x</sub>.

1996 for CO<sub>2</sub> (data for 1995 not available).

GDP at 1991 prices and purchasing power parities.

Source: *OECD Environmental Performance Reviews: Denmark, 1999.*

Electricity and heat production account for large fractions of national emissions of CO<sub>2</sub>, SO<sub>x</sub> and NO<sub>x</sub>. Public electricity and heat production was responsible for about 29 million tonnes of CO<sub>2</sub> emissions from fuel combustion in 1995 (Energy Policies of Denmark 1998, p. 44, IEA). This is 48% of the national total. In 1996 electricity generation accounted for about 145 thousand tonnes of SO<sub>x</sub> (82% of the total) and about 128 thousand tonnes of NO<sub>x</sub> (44.6% of the total), (Environmental Performance Reviews, Denmark, OECD, 1999, p. 53). Hence, electricity and heat production are influential if not determinative in reaching national environmental goals.

Denmark has significantly improved its environmental performance over the past two decades ... Total emissions of CO<sub>2</sub> fell by 7% in real terms and by 14% when corrected for climatic variations<sup>13</sup> from 1980 to 1996, largely due to the introduction of CHP, switching to cleaner fuels, energy conservation and efficiency measures and renewables. However, CO<sub>2</sub> emissions from fuel combustion increased by 13% from 1990 to 1995, and by 23% from 1995 to 1996; this acceleration was caused by the large increase in electricity exports in 1996. Emissions of SO<sub>x</sub> fell 62% from 1980 to 1996. Emissions of NO<sub>x</sub> fell 5% over the same period.

Denmark has set environmental targets that are ambitious as compared with historically achieved improvements. The country has made tremendous progress over the past two decades, but the high share of coal-fired generation implies relatively high rates of emissions for CO<sub>2</sub> and NO<sub>x</sub>. However, according to the Economic Council, "The official Danish target for 2005 to reduce Danish carbon dioxide emissions to a level 20% below that for 1988 cannot be achieved with the present taxes. By 2020 a tax of DKK 800 per tonne of carbon dioxide would be needed to sustain the 2005 target level."

## 2. STRUCTURE

The electricity sector in Denmark is integrated with district heating and with neighbouring countries, but is itself split into two separated electricity systems. The sector is largely vertically integrated. Much heat and electricity are jointly produced, and government policies applied to electricity, heat and natural gas are highly integrated. Large transmission connections with neighbouring countries, and the resulting significant international trade, mean that Denmark is often part of a larger, international market for electricity. Because domestic generation is dominated by Elsam and Elkraft, non-discriminatory access by Danish customers to transmission abroad is a key factor for promoting competition and efficiency in generation. However, when transmission from abroad is congested, then Denmark constitutes at least two economic markets, each dominated by one generator and separate from the rest of the Nordic region. Much transmission capacity is already tied up by pre-existing long-term contracts, and there are many agreements and some cross-ownership with some of the potentially competitive foreign generators.

## 2.1. *Elsam and Elkraft*

Elsam, in western Denmark, and Elkraft, in eastern Denmark, while often considered to be similar, differ in many respects. They differ in their legal form, internal organisation, concentration of ownership and control, and activities. Elsam and Elkraft have *de facto* integrated the generation capacity of the companies that compose the two groups. They are often the parties in the electricity industry that enter political agreements regarding, *e.g.*, environmental public service obligations, with Government. They enter into a variety of agreements with foreign generators. Thus, the two groups, despite their differences, play similar economic roles.

Elsam is a partnership of six partners, the generating companies in Jutland and Funen. Elsam is responsible for commercial activities for its partners: planning and control of generation, electricity trading, procurement/handling of fuels, and financing of new plants. Regional groupings of distribution undertakings own the generating companies. I/S Eltra, a partnership of the same distribution undertakings, is responsible for all network activities and system operations in the West Denmark area. Rapid consolidation of the distribution companies is taking place, leaving 56 in western Denmark in mid-1999. Since Eltra purchases, itself, back-up energy for the region, amounting to transactions of 1.5 TWh/year, it is a large market player in its own right. Eltra owns the 400 kV transmission network, and has complete control over the Konti-Skan link with Sweden. However, Elsam itself retains control over the Danish share (600 MW) of the Skagerrak link with Norway.

Elkraft's ownership and control is much more concentrated. Two generating companies, Sjællandske Kraftværker (SK Power) owns 80% of Elkraft and Københavns Belysningsvesen (Copenhagen Power) the remaining 20%. NESAs, the largest distribution company in Denmark with 20% of total national consumption, owns 53% directly, 59% including co-partners, of SK Power. Consolidation may take place in future., Elkraft has the legal form of a co-operative with limited liability. Elkraft performs many of the same, albeit fewer, activities as Elsam. The system operator is Elkraft System, a unit within Elkraft that is has accounts and information system separate from the rest of Elkraft, but does not have separate management, personnel, etc. Elkraft owns and operates the 400 kV network in its area, as well as the connections to Sweden and Germany. As discussed below, the new electricity legislation requires the system operator to be a separate legal entity.

Elsam and Elkraft control the generation in their respective areas. As noted above, Elsam actually operates the six Jutland-Funen central generating plants.<sup>14</sup> Generation costs are 'pooled' with the generating companies charged the same, time-differentiated price for power, where total revenue equals total cost. Elkraft operates slightly differently, buying power from its constituent generating companies and from generators in Sweden and then re-selling to its generating companies. It, too, 'pools' the cost of generation within the co-operative.<sup>15</sup> In both groups, the generating companies individually set the prices at which they re-sell to the distribution/supply companies. The pooling of generation costs within the two groups diminishes individual generating companies' incentives to reduce their own costs, since they would have to share the benefits of the cost reduction with the other firms in the pool.

The centralised control over generation imply that Elsam and Elkraft, rather than the eight generating companies, are the "strategic players" in Denmark's electricity sector.

## 2.2. *Generation*

The control of generation in Denmark is very concentrated, but the negative effect on competition is somewhat ameliorated by foreign generators and international transmission capacity, which make it possible for foreign generators to supply Danish electricity consumers. The competitive



significance of the foreign generators is, however, diminished by marketing agreements and cross-ownership with Danish generators, and limited uncommitted, independently controlled transmission capacity. The competitive significance of smaller Danish generators—wind turbines and small scale CHP—is less than would seem from market share figures: non-dispatchable generation, or generation constrained “on” or “off” because of heat obligations, cannot behave strategically in electricity markets. There was about 53% surplus capacity.<sup>16</sup> However, this figure overstates the excess as it does not take into account Norwegian and Swedish consumption, which Danish capacity supplies in dry years.

Almost four-fifths of Danish generating capacity is controlled by Elsam or Elkraft. Industrial autoproduction accounted for only 300 MW (less than 3% of the total) in 1997.<sup>17</sup> The structure of Danish generation is provided in the tables below. The capacity figures must be interpreted in light of the high level of joint production of electricity and heat: the large plants have a lower capacity to produce electricity when they must also produce heat, and the small CHP plants do not produce electricity unless they are producing heat.

Elsam’s sales in 1998 were about 14.5 TWh, of which about 12.5 TWh was sold in Denmark and about 2 TWh was exported. Heat production was about 35 PJ.<sup>18</sup>

Table 4. **Structure of generation in Western Denmark**

Elsam (6 generating companies)	Large, central plants	4 500 MW	
	Small CHP plants	160 MW	
	Wind plants	125 MW	
	Sub-total		4 785 MW
Other owners	small CHP plants	950 MW	
	other small plants	200 MW	
	wind plants	775 MW	
	sub-total		1 925 MW
Total			6 710 MW

Source: Eltra’s web site, <http://www.Eltra.dk/>.

Table 1. **Table 5. Structure of generation in Eastern Denmark**

Elkraft (2 generating companies)	Large, central plants	3 893 MW	
	Small CHP plants	293 MW	
	Wind plants	112 MW	
	Sub-total		4 298 MW
Other owners	Small CHP plants	265 MW	
	Wind plants	226 MW	
	Sub-total		491 MW
Total			4 789 MW

Source: Elkraft.

Wind turbines have relatively dispersed ownership: A bit over 80% of the total installed capacity is not owned by utilities. Wind accounts for about 8% of annual generation. Wind turbines are not dispatchable: unlike other generating units, their provision of electricity to the system cannot be controlled by a central dispatcher, but instead depends on the wind. Hence, despite their large share of generating

capacity relative to international standards, they cannot behave in a strategic manner in an electricity market. Rather, wind turbine owners would be price-takers in a free market, selling into the market at the prevailing price when the wind blew. Therefore, wind generators would not have a direct effect on competition in generation, although they would, in essence, shift the demand for electricity faced by the strategic players.

Small CHP plants also have a smaller competitive influence than indicated by market share figures. Decentralised CHP accounts for about one-third of annual generation. They produce electricity only when they produce heat, and electricity capacity increases with heat output. Therefore, when heat demand is low, their capacity to produce electricity is low. While some heat is storable, heat production nevertheless constrains the production of electricity by small CHP plants. This, in turn, limits feasible market strategies for small-scale CHP.

The rules for dispatch can affect competition among generators. In Denmark, these rules specify that all electricity generated by wind turbines and decentralised CHP plants must be taken. This confirms the role of wind and small CHP as “inframarginal” (*i.e.* non-price setting) generation.

In summary, four-fifths of generation in Denmark is controlled by Elsam and Elkraft. Much of the remaining Danish generation cannot, for technical reasons, act in a strategic way in an electricity market. Hence, foreign generation must be relied upon to provide competition.

### 2.3. *Transmission*

The 400 kV transmission networks in Denmark are owned and operated, in their respective regions, by Eltra and by Elkraft. There are large transmission connections to foreign countries; some of these capacities are reserved for pre-existing long-term supply contracts, and the operational capacities can be constrained below nameplate capacity.<sup>19</sup> There is no transmission line across the Great Belt linking the regions of Elsam and Elkraft. Additional north-south transmission capacity will come on line in the next few years.

Table 6. **Electricity transmission to other countries**

<b>Danish Endpoint</b>	<b>Foreign Endpoint</b>	<b>Nameplate Capacity and Type</b>
Eltra	Germany	1 400 MW alternating current
Eltra	Norway	1 040 MW direct current
Eltra	Sweden	630 MW direct current
Elkraft	Sweden	1 775 MW alternating current*
Elkraft	Germany	600 MW direct current

\* 1 700 MW from Denmark to Sweden.

Eltra was set up in late 1997 to comply with the requirement in the European Union electricity directive for an independent and neutral system operator. The 1999 Danish legislation further required that the transmission system operator be in a legally separate company from generation. Eltra is responsible for system operation including dispatch, owns and operates the 400 kV transmission network and the foreign connections, and operates over-100 kV transmission. The partners who own Eltra (the distribution companies in the Jutland/Funen area) approve its annual report, accounts and budget, and elect the Board. Hence, Eltra has separate accounts, board of directors, and legal identity from generation, but is not separate from Elsam in terms of the ultimate ownership or control by the distribution companies.<sup>20</sup>

Elkraft SYSTEM is the unit of Elkraft responsible for system operation in its area. It has separate accounts and information system from those of the remainder of Elkraft. The new legislation requires the system operator to be a separate legal entity.

The Western area of Denmark has transmission links to Norway (Skagerrak), Sweden (Konti-Skan), and Germany. 600 MW of the Skagerrak capacity is taken up with an agreement between Statkraft and Elsam on the exchange of firm power. This agreement was entered in 1995 and has a duration of 25 years.<sup>21</sup> Elsam has paid DKK 620 million and DKK 545 million in 1997 and 1998, respectively, under this agreement.<sup>22</sup> Another 400 MW of the Skagerrak capacity is taken up with a power exchange agreement between Statkraft and PreussenElektra.<sup>23</sup> This leaves very little capacity available for other southbound transactions. The capacity of the Konti-Skan link had been taken up by a long-term contract between Vattenfall and Elsam. However, this contract has been renegotiated and apparently the capacity is now available to market players.

The evolution of the system for reservation of Eltra's transmission capacity illustrates the importance of non-price aspects of grid access. Under the access rules in place in early 1999, the capacity could not be used to transport energy to Denmark on a very short-term basis. Those who wished to use the capacity had to make a request three months in advance, and reconfirm its usage two weeks in advance. Thus, if a Swedish generator found a Danish customer on short notice, the supplier would not be able to use the Elsam-Sweden line to transmit the power. In addition, the reservation system gave preferences for electricity that is to be used by Danish consumers. Both aspects of these access rules resulted in inefficient use of the capacity. Subsequently, the rules were changed. In late 1999, there was a monthly auction for capacity on the Danish/ German border. Unused capacity was offered on a day to day basis. From 1 January 2000, the available capacity on the Danish/German border will be allocated on a daily basis. Allocation of capacity between Denmark and Norway and Denmark and Sweden follows NordPool rules. However, these rules will not affect pre-existing agreements.

It is striking that there is no interconnection across the Great Belt. The Electricity Supply Act gives to the Minister for Environment and Energy the power to order one to be built. (Section 13) Investors are reportedly reluctant because the systems have very similar production and consumption patterns, which would presumably reduce gains from trade. Further, Elsam and Elkraft are not synchronised, increasing the cost of a transmission link. (Grohnheit, Poul Erik and Olsen, Ole Jess, 1997). However, the interconnection would enable Elsam and Elkraft to directly and more fully compete with one another, which might have sufficient efficiency effects to justify the cost of the link.

The key transmission issue is to have an access regime that cannot be used to exclude or erode competition from foreign or domestic generators. Transmission tariffs are regulated. The new law and commentary on the Law state that revenues from transmission should not exceed costs, that the costs "are to be shared among the purchasers of the services in accordance with reasonable, impartial criteria" and that "access...takes place on objective, transparent, reasonable and uniform conditions, and at price that has been established beforehand."<sup>24</sup> The Competition Authority has said that it would take action against access terms and conditions that foreclose competition. But there can be harm to competition when some firms are discriminated against, even when not foreclosed, and when non-discriminatory prices are higher than necessary either from exploitation of monopoly power or from inefficiency. If independent foreign or domestic generators are expected to sell electricity to Danish consumers, then it will be important that the implementation of the law ensures equitable transmission access.

## 2.4. *International trade*

Foreign generators might be expected, in a liberalised market, to provide significant competition to supply Danish electricity consumers. The expectation is even greater because Denmark already has substantial international trade in electricity. Since many of the regional generators use hydropower and, to a lesser extent, nuclear power, increasing their sales in Denmark would lower global CO<sub>2</sub> emissions. However, the competitive significance of foreign generators is diminished by cross-ownership, agreements and joint ventures between the foreign generators and Danish entities, and the structure of control over the international transmission interconnections.

The Danish Government has expressed concern that increased international trade and liberalisation may make attaining the environmental goals more difficult. “The Danish Government supports the implementation of the [European Union] internal energy market on the clear understanding that the opening of the market does not counteract the possibilities of improving the environment”<sup>25</sup> [Section 1.2, 3]. There is some concern, but also an appreciation, that reform and the environment are not incompatible so long as the current dilemma which faces all European countries is resolved, that is to say, the need to match the establishment of common rules for the liberalised electricity market with common rules for environmental policy.

The main generating companies in the broader region are Vattenfall, Sydkraft, Fortum, Statkraft, and PreussenElektra. Ownership connections among Sydkraft, Statkraft, and PreussenElektra reduce, however, this to only three independent large generating groups. There are many smaller generators in both Norway and Sweden, as well as two large generators in northern Germany, RWE and VEAG, but neither of the German utilities has been known to solicit Danish customers.

**Vattenfall AB**, the largest generator in Sweden, accounts for about 50% of sales in Sweden,<sup>26</sup> and is one of the largest energy groups in the Nordic countries, with over 20% of electricity sales in the region. It is owned by the Swedish State but is operated commercially. Almost all of its electricity (83.8 TWh in 1998) is generated from nuclear and hydro plants.<sup>27</sup> A high but decreasing share of its sales (81% in 1998) are within Sweden. NESÅ A/S, the majority owner of Elkraft and large distribution company in Zealand, is partly owned by Vattenfall.

**Sydkraft** is the second largest Swedish generator, with about 20% of sales in Sweden.<sup>28</sup> It is owned by PreussenElektra (17.6%) of Germany and Statkraft (17.1%) of Norway<sup>29</sup> as well by as municipalities, pension funds, and individual investors. PreussenElektra and Statkraft each appoint two members of the Board of Directors. Sydkraft has entered the Danish market, gaining three customers in 1998—Novo Nordisk (pharmaceuticals), Aalborg Portland, and DISAM, a large distributor on Jutland.<sup>30</sup>

**Fortum** is another large energy group. This group includes Imatran Voima Oy (IVO), the largest generator in Finland, with 8 700 MW generating capacity in Nordic countries in 1997. IVO owns 50% of Birka Energi AB, the third largest energy company in Sweden, accounting for about 15% of total electricity sales.<sup>31</sup> It was, in turn, formed from the 1998 merger of Gullspång Kraft AB and Stockholm Energi AB.<sup>32</sup>

**Statkraft** is the largest generator in Norway. With a capacity of 34TWh, almost entirely hydropower, it has about 30% of Norway’s total. It is owned by the Norwegian state, but operates commercially. It owns 20% of Olso Energi Produksjon (7 436GWh in 1997),<sup>33</sup> as well as the above-mentioned stake in Sydkraft.<sup>34</sup>

**PreussenElektra**, a fully owned subsidiary of VEBA AG, is the second largest utility in Germany and the fourth largest in Europe. It generated 66.6 bill. KWh in 1997, and bought 43.1 bill. KWh from others.<sup>35</sup> PreussenElektra jointly operates a large power plant in southern Jutland, EV3 in Apenrade, with a regional utility that is one of the Elsam partners.<sup>36</sup> Under this agreement, PreussenElektra's share is required to be exported to Germany. However, this does not prevent PreussenElektra from exporting other electricity into Denmark.<sup>37</sup>

The Danish electric utilities have signed a number of agreements with foreign electric utilities:

- Elsam entered a marketing co-operation agreement in 1998 with IVO, now part of Fortum.<sup>38</sup>
- Elsam entered a separate co-operation agreement in 1998 with Öresundskraft to sell into eastern Denmark. Öresundskraft is a Swedish company with about 1 300 GWh annual turnover.<sup>39</sup>
- Sydkraft and three Zealand companies, Københavns Belysningsvesen (KB, Copenhagen Power), SEAS Distribution, and Nordveststjellands Elförlýsning (NVE), formed a Danish electricity sales company in 1999 to sell to liberalised Danish customers.<sup>40</sup>
- Vattenfall and NES A/S, the largest Zealand distribution company, signed a co-operation agreement in February 1998 to found a joint marketing company to penetrate the Danish electricity market (Vattenfall, 1998).
- Sjællandske Kraftværker (SK Power), the main generator of electricity on Zealand, and Swedish Vattenfall AB are jointly building a 485 MW multi-fuel plant. Rules for its commercial operation are not public.<sup>41</sup>

This web of marketing agreements and ownership connections poses a strong threat to the development of competition in the region. They reduce or eliminate competition between the firms involved. It could be argued that they are beneficial as the fastest and cheapest way for a potential competitor to enter the Danish market may be as a partner with a knowledgeable incumbent. However, Sydkraft had already won three big Danish customers in 1998, before it entered the marketing agreement with the Zealand companies. This experience shows that the large Nordic companies do not need local partners to sell to large Danish customers, thus that the marketing agreements serve to reduce competition rather than to facilitate otherwise difficult entry. While one might speculate that foreign companies would require local brand name recognition to sell to, *e.g.*, Danish households, these consumers will not be free to choose suppliers until 2003, under current plans, so marketing agreements in 1998 and 1999 would seem to be premature.

#### 2.4.1. *NordPool*

Western Denmark has joined the Nordic Power Exchange (NordPool). This will reduce transactions costs of buying power from abroad, but transmission constraints will still have a real effect on the level of competition enjoyed by Danish consumers. In particular, a market for financial instruments cannot overcome the physical constraints of the underlying commodity, electricity.

NordPool is a series of markets for the trading of electricity, incorporating Norway, Sweden, Finland (since 1997) and the western part of Denmark (since 1999). There are about 256 participants, a few of which are Danish. Hourly power contracts for physical delivery during the next 24-hour period are traded in the Spot Market (Elsport). The Futures Market (Eltermin) trades purely financial instruments for

hedging the price of power contracts up to three years into the future. NordPool also clears bilateral futures contracts, assuming the counterparty risk that would, in the bilateral market, be borne by participants. Only a fraction of total consumption in the NordPool area is traded in NordPool. According to NordPool, in 1998, turnover in the Spot Market was 56.3 TWh, and turnover in the Futures Market was 89.1 TWh.<sup>42</sup>

An indication of how well the NordPool area corresponds to a market, in an economic sense, is provided by how frequently prices were uniform across the area. There were multiple price areas in the NordPool area in 41% of the hours in 1997. This suggests that, as studies by Borenstein *et al* have shown for other regions of the world, the geographic extent of the relevant market (as defined in antitrust analysis) in the Nordic area varies over time. Borenstein *et al* showed that markets are smaller during peak periods and larger during off-peak periods (Borenstein, *et al.*, 1997)

A clear indication that Denmark is often a separate economic market from the rest of the NordPool region is that the Eltra region has been incorporated into NordPool as a separate bidding area. This shows that the Eltra region is expected to have different prices from other NordPool price regions over a significant fraction of time.

Table 7. Trade in Nordic Countries 1997 (Gwh)

		Importing Country					
		Denmark	Sweden	Norway	Germany	Finland	Russia
Exporting Country	Denmark		5244	1723	3382	0	0
	Sweden	938		6800	832	4382	0
	Norway	1084	3652		0	89	0
	Germany	1072	400	0		0	0
	Finland	0	929	139	0		0
	Russia	0	0	188	0	4272	

Source: Annual Report 1997, NordPool.

## 2.5. Natural gas

There is a single supplier of natural gas in Denmark, although there are also five regional monopoly gas distribution companies.<sup>43</sup> The supplier is owned by the central government; the regional distribution companies by local government. The regional distribution companies have a non-competition agreement, approved by the Minister for Environment and Energy. Thus, no customer has a choice of supplier, unless he is able to move between regions.

## 2.6. District heating

About 75% of all heat for district heating is produced jointly with electricity.<sup>44</sup> Essentially all major electricity generating plants produce heat for district heating. The extensive joint production implies that the regulation of heat can constrain feasible regulation and competition in electricity.

Most district heating distribution companies are owned by municipalities or consumer co-operatives. Decentralised cogeneration plants have similar owners, or are owned by central power stations. There is very little vertical separation amongst the various activities of district heating—production, transport, and retail sales.

Table 8. **Production and use of district heating 1996**

PRODUCTION/USE	ENERGY CONTENT (TJ)
Production (net)	126 657
Centralised power stations	69 581
Decentralised power stations	27 301
District heating plants	24 914
Private (industrial) producers	4 861
Imports	122
Distribution losses	-25 356
<i>Total consumption</i>	<i>101 423</i>

Source: Energy authority energy statistics 1996.

The requirement that new electricity generation also produce heat means that new entrants must find buyers for the heat. The vertical integration of district heating and the joint production of most heat with electricity means that the incumbent distribution companies that also own generation would only switch to buying from the new entrant if the incumbent were compensated for foregone profits from both heat and electricity production. This is a higher standard to meet than being able to offer electricity (or electricity plus heat) at an average cost lower than the non-sunk costs of the incumbent, the usual standard for entry when there is no vertical integration. Thus, the requirement to produce jointly heat and electricity reduces entry. Presumably it also results in a higher cost of producing electricity and heat, since otherwise generators would have shifted voluntarily to this technology.

## 2.7. *Ownership*

Consumer co-operatives and municipalities are the ultimate owners in this sector. This ownership structure is justified as a means to provide consumers with enhanced influence and protection. Consumer ownership provides consumers with a theoretical direct influence, and municipal ownership provides citizen-consumers with a theoretical influence via their municipal representatives.

However, these ownership arrangements may not serve consumers adequately. A report by Andersen Management International A/S<sup>45</sup> found that, in practice, consumer ownership does not provide consumers with influence over distribution/supply companies. Further, the term “ownership” is somewhat misleading: Consumers do not have an equity interest in the sense of having rights to profits or to dispose of the company’s assets, or liability for the company’s debts. Hence, ownership of these companies does not confer the usual incentives of ownership toward cost minimisation.

Ownership by co-operatives and municipalities also distorts managerial incentives for economic efficiency. The pattern in Denmark of electricity company boards having numbers of local politicians<sup>46</sup> suggests that the political system is an important factor in the management of the utilities thus diminishing the role of a managerial labour market in screening and disciplining managers. However, take-overs are now occurring among distribution companies, and this might increase the scope for a managerial market.

Incentives for the municipalities to transfer ownership of electricity companies are weak due to a provision of the Electric Supply Act. According to this provision, if a municipality sells its electric supply business, then the block grant from the central government would be reduced by the amount equal to the net proceeds of the sale. In essence, the sale would be “taxed” at 100%. No such sale has taken place. Sales of other assets by the municipalities are not subject to a similar block grant reduction.

**Box 1. Andersen Management International's conclusions on consumer ownership and consumer protection**

Consumers have little influence over the electricity sector in practice.

Generally speaking, the sector is largely unaware of what consumers actually want and need. Nor has much attention been paid to service-type functions, including dealing with customer enquiries and complaints. To a large extent, the current technical/specialist corporate culture is based on the idea that the companies know what consumers need best.

There are considerable differences between the theoretical possibilities for influence which consumers have via ownership, and if companies listen to consumers, it is because they have to rather than want to.

It is only by being able to choose that consumers can safeguard possible interests in having environmentally and energetically correct electricity and heat. At present, consumers as general customers have no way of safeguarding these interests, *e.g.* by choosing between green and normal energy.

Other major infrastructure areas, such as telephones, railways and post, do not have the same links between ownership and representation of consumers' interests. In these areas, general consumer protection legislation and the possibility of choosing from amongst different suppliers are what protects consumers' interests.

The energy policy authorities frequently state that consumers' interests are protected by their role as owners, but on the whole ownership is not an effective way of doing so. Politicians and administrators should recognise that ownership does not automatically protect consumers' interests.

The governance of the sector needs to be strengthened in step with regulatory reforms. A precondition for efficient management is a clear separation between company objectives (*e.g.* cost-efficiency), for which management is to be held responsible, and other wider objectives that are the responsibility of the various levels of government. The latter can be more efficiently advanced through regulations that constrain but do not interfere with the management of the utilities. In addition, governance needs to be strengthened to cope with the new challenges and to take advantage of the new opportunities made possible by the reforms. For example, as supply companies can make more choices about where to procure their electricity, their management will have to make decisions about buying and selling from NordPool that they have never before faced. One example of difficulties faced by newly liberalised companies is provided by American electricity companies. The price spike in the American Midwest in summer 1998 was attributed, in part, to inexperience in real-time electricity trading by the utilities.

### **3. REGULATORY FRAMEWORK**

The electricity sector in Denmark is heavily regulated in some "physical" aspects—*e.g.*, fuel choice, CHP—but rather lightly regulated in some economic aspects. The principal national law governing the sector as of August 1999 is the Electricity Supply Act (Act no. 486), which entered into force at the beginning of 1998. The Energy Supply Act (Act no. 375) adopted on 24 May 1999 has not yet entered into force (changes introduced by the new law are described in section 4 below). As a member of the European Union, Denmark is also governed in accordance with European Union directives and regulations. The main lines of the Directive on the EU internal market for electricity are described in Box 2.



### Box 2. EU Directive on electricity liberalisation

The Council of the European Union adopted a directive on the internal market for electricity (EC 96/92) on 19 December 1996 (EC, 1996). EU Member States have (with some limited exceptions allowed by the directive) implemented the directive into their national laws by 19 February 1999.

Under the directive, increasing shares of electricity markets must be opened to competition, based on size of user. For 1999, the group of largest users accounting for, at least, 26.48% of the market has a choice of supplier. This percentage increases to 28% in 2000 and 35% in 2003. In practice, the minima mean that only large users (average of 9 GWh annual consumption or greater - with a typical annual electricity bill of 500 000 euros or greater) get the opportunity to choose suppliers, although member states can or have gone further (*e.g.*, England and Wales, Sweden, Germany).

Access to the grid is via a transmission services operator who must be separate (at least as a separate business unit) from generation and distribution businesses (distributors must have a distribution service operator who may be the same or not, as the transmission operator). EU Member States can choose from three different procedures for access. Under regulated third party access (as in England and Wales), the most liberal option, tariffs for third party access to the networks are regulated, published and are available to all parties. Under negotiated third party access (as in Germany), eligible consumers or generators/suppliers can negotiate network access with the incumbent utility. Prices and access terms are agreed freely among them and are confidential. The system operators must be involved in the negotiations and must publish an indicative range of transmission and distribution prices on an annual basis.

The third possible approach is the single buyer system, (so-called because a designated single buyer sells all electricity to final consumers) under which eligible consumers are free to conclude supply contracts with generators/suppliers both inside and outside the incumbent utility's territory. The single buyer purchases the electricity contracted by an eligible customer from a producer at a price which is equal to the sale price offered by the single buyer to eligible customers minus a tariff for network services.

There are two options for generating capacity additions. Under the tendering procedure, the monopoly utility determines when new capacity is required and conducts a tender for this requirement. Under the authorisation procedure, the timing of generating capacity investments is the responsibility of individual investors, provided that they meet criteria specified in advance by the Member State (*e.g.*, environment, land use, public safety) for grant of an authorisation to construct. Member States may also opt not to require a procedure and leave the addition to market forces.

The directive contains significant provisions which may delay or affect the development of open markets. Member states may impose public service obligations to ensure "security, including security of supply, regularity, quality and price of supplies and ... environmental protection". Furthermore, "to avoid imbalance in the opening of electricity markets" the directive permits the imposition of reciprocity requirements *i.e.*, a customer who has choice in one member state may be prohibited from obtaining supply from a supplier in another member state where customers of the same type do not have choice. The directive also permits Member States to impose a requirement that up to 15% of fuels to be used in the generation of electricity come from indigenous sources.

Requirements for international trading or "wheeling" of electricity within the EU were originally set out in the transit directive (EC, 1990).

The Directive is to be reviewed with the intent of implementing further reforms 9 years after the original directive (*i.e.*, 19 December 2006). An implementation group has been set up by the European Commission to discuss how the directive will be implemented in member states.

### 3.1. Institutions

The Danish Energy Agency (DEA), an agency within the Ministry of Environment and Energy, is responsible for energy policy formulation and implementation. The DEA administers Danish energy legislation, notably the Electricity Supply Act, the Heat Supply Act, and the Natural Gas Supply Act. The Agency also implements policy through agreements with, notably, Elsam and Elkraft. The DEA is responsible for the overall planning of power, heat, and natural gas. It issues licenses and administers several subsidy programmes.

The Electric Price Committee and Gas and Heat Price Committee regulate prices.<sup>47</sup> The Electricity Price Committee, consisting of a chairman and eleven other members, is appointed by the Minister for Environment and Energy. Whereas the chairman and five members are independent of any interest in electricity supply, heat supply or municipality, the other six members do have such interests. The Competition Council supplies the secretariat to the Committee. The Electric Price Committee and the Heat Price Committee always have the same chairman and staff, a policy intended to maintain coordination between the pricing regimes.

The Competition Act applies in the electricity sector provided that it is not in conflict with the Energy Supply Act. Two sections would seem particularly relevant, since the notes accompanying the provisions refer to access to the electricity networks. Section 11 makes illegal the abuse of dominant position. Section 16(4) allows the Competition Committee, under certain circumstances, to impose obligations, “to provide access to an infrastructure which is needed to be able to offer a product or service....” Further, the Competition Commission has said that refusal to give third-party access to the transmission network would constitute a limitation on competition, and it would order access if it were not attained through negotiation.

### 3.2. *Instruments*

Denmark uses a wide variety of regulatory instruments. These instruments vary in their market-compatibility. Taxes and subsidies, for example, allow for the decentralised decision-making inherent in markets but others, such as direct regulation through negotiated political agreements, licensing, and price regulation, are more difficult to combine with markets.

**Political agreements** between the Government and electricity companies are the means by which many public service obligations, which would otherwise not be economic, are carried out. For example, in the past the decision to construct coal fired plants was based on a political agreement. More recently, under the terms of a 1997 agreement, the utilities will build five offshore wind farms, totalling 750 MW (about 8% of Danish consumption), by 2007 (Minister of Environment and Energy to the Energy Committee in the Folketing, 1998). Another example is the “Biomass Agreement,” under which the type and amount of biomass to be used by the large-scale generating plants are specified.<sup>48</sup> A 1985 agreement between the Ministry of Energy and the electric companies was to expand wind capacity by 100 MW by 1990.<sup>49</sup> The construction of more than 100 decentralised gas-fired CHP plants in the first half of the 1990s, when the first such plant was constructed only in 1987, is another example.

The law provides broad powers for the Minister for Environment and Energy to reach these agreements. For example, under the ESA, the Minister for Environment and Energy may require an electricity enterprise *inter alia* to equip its generation facilities to use prescribed forms of energy or configure its generation facilities to achieve the greatest possible energy efficiency. The Minister may require an electricity supply enterprise to maintain a necessary minimum capacity in Denmark (Sect. 13).

It is difficult to reconcile these agreements with uniformity of legal and regulatory treatment or so-called level playing fields and, in the move to a competitive market, these policy decisions could create stranded costs and liabilities for the public sector.

**Licenses** from the DEA are required for plants exceeding 25 MW and for transmission over 100 kV. Licenses are granted conditional on technical requirements and demand assessment.

**Economic regulation** is applied to electricity prices so as to have total revenues equal total accounting costs, with special provisions for future capital investments. The regulation is described in greater detail below. There is also economic regulation of heat and gas that has effect on electricity.

The **tax and subsidy regime** applied to energy is very complicated. Essentially, taxes and subsidies differ depending on the fuel, the use to which the energy is put, some characteristics of the final consumer of the energy, and sometimes the identity of the final consumer. Some subsidies are paid per kWh, and others (for investment) are independent of the amount of energy produced. Some taxes are reduced, pursuant to individual agreements between the regulator and the companies, in return for energy efficiency investments. The combination of regulated prices, taxes, and subsidies, acting both on a marginal and fixed basis, yields a system where net price signals received by suppliers and consumers can bear little resemblance to relative costs.<sup>50</sup>

### 3.3. *Economic regulation until the 1999 Reform*

The sector is regulated so that total revenues equal total costs. Revenues can include provision for future capital expenditures.<sup>51</sup> Combined with the limited oversight provided by consumer co-operatives and municipal owners, this system of economic regulation does not provide incentives for least-cost operation, nor for efficient use of capital. In addition to accounting profits, entry into electricity generation is also regulated. The prices of natural gas and of heat are regulated, and these too affect the electricity sector.

The zero accounting profits rule contains rather complicated issues: Which costs are covered, and how are the revenue streams assigned to different customers? While in principle, covered costs are those costs that are incurred by a company that is run technically and commercially reasonably, in practice it is difficult for the regulator to detect unnecessary costs. Indeed, the Electric Price Committee has not had information about how companies could reduce costs, and has not required the companies to use “benchmarking” of productivity. This reduced oversight has been blamed for the large difference in costs of distribution across Denmark.

One example of the rather informal type of tariff benchmarking employed is provided by Copenhagen Energy (CE). The company has explained that its municipal owners were primarily concerned about electricity prices charged to households. The owners compared the price of electricity sold by CE to the prices charged households across the rest of Denmark. If the prices charged by CE were sufficiently low, then the owners did not seek further efficiency improvements or price changes.

### Box 3. Incentive regulation

Regulation so that revenue equals cost does not provide incentives for a firm to reduce its costs, nor to seek profitable new customers. If a firm did reduce its costs, then it could not keep the resulting profits, but rather would have to pass the cost savings onto consumers as reduced revenues. If a firm did find a profitable new customer, then it could not retain those additional profits, but would have to reduce its revenues from the existing customers. Similarly, losing a profitable customer would not entail a profit loss, but rather increasing revenues from remaining customers.

Some countries use so-called incentive regulation, which provides profit-seeking firms with incentives to reduce costs. For example, price caps set maximum prices that a firm can charge for one or several products. (This is often referred to as “RPI minus x” regulation, after the British formulation.) The firm bears the profit risk, making more profits if it reduces costs or increases revenues, and losing money if it fails. Hence, it has incentives to seek innovative ways to reduce costs and to increase the value of its products for customers.

Another form of incentive regulation of profit-seeking firms is yardstick competition or “benchmarking.” Under this form of regulation, the price a firm can charge is a function of the costs other firms incur, as well as its own costs. The more homogeneous the firms are, the more the price depends on the other firms’ costs. Here, too, the firm bears much of the profit risk, making more profits if it can reduce costs more than the firms used for comparison.

Clearly, incentive regulation does not necessarily enhance economic efficiency if the firms are not profit-seeking.

The present form of economic regulation will be changed to encourage greater efficiency in the monopolistic segments of the industry. Grid and transmission companies will be subject to a new regulation based on benchmarking and profit incentives will be introduced to promote cost efficiency. Companies with an obligation to supply retail customers will be allowed a regulated profit which will depend on their ability to offer low prices. At present, distribution companies are bound by contract or their articles of association to buy electricity from the generating companies of which they are joint owners.<sup>52</sup> If these obligations were abolished then, as pointed out by the Competition Authority, “the term ‘necessary expenses’ as used in electricity legislation could also include the distribution companies’ costs in acquiring supplies of electricity. This means that the retail supply companies’ purchases from production companies which have the same owners cannot perhaps be regarded as necessary expenses if they can buy more cheaply elsewhere. Alternatively, this could come under § 10 para. 4 of the electricity supply law on unreasonable terms of supply”<sup>53</sup> (Section 6.2.1).

The other half of the regulatory puzzle is setting a price regime that results in the appropriate level of revenues. Customers are to pay the “rational costs of energy supply” (called “self-sustainability” in Denmark). In practice, customers are grouped into three classes, based upon the voltage at which they take power. Tariff structure is not specified in the law. Most customers pay a fixed charge and a variable charge. For large customers (optionally for small customers), the variable charge has three levels, peak, high, and off-peak. Peak price is about three times off-peak; the off-peak price is set so to equal the variable cost of a baseload plant.<sup>54</sup> However, as a result of the ongoing reforms, the tariff structure is changing.

The regulatory treatment of future capital expenditures encourages excess investment through under-pricing of capital. The utilities can collect revenues to make advance provision for future plants, up to 75% of the estimated capital cost, starting, at 20%, five years in advance (Elsam’s Annual Report 1997, p. 19). In practice, these provisions are substantial: 91% of Elsam’s tangible, fixed assets are financed this way (Elsam’s Annual Report 1997, p. 23). Utilities do not pay interest on this capital; instead, consumers pay through their foregone returns on investment. This practice can explain the low rate of indebtedness of the Danish electricity utilities relative to those in other countries, as well as, in part, their over-capacity. Also, since the prices charged consumers for electricity is net of the payment to capital,<sup>55</sup> prices are lower than they would have been if the electricity sector had financing practices and ownership structure like those of other sectors. The new regulatory framework will not allow investments to be financed with advance provisions in the regulated tariff thus aligning the cost of capital for electricity investments with normal market values.

Entry into generation is regulated in several ways. Under the new regulatory regime, criteria for new investments in electricity generation have not yet been stipulated. The industry has entered into political agreements outside the framework set by the DEA on coal, CHP and wind farms. For example, new electricity generation has been required, since the early 1980s, to be CHP and have the ability to supply heat to the district heating networks. Thus, the policy is that new electricity generating capacity must also produce heat; therefore it must find demand for its heat output and be approved by the local authority.<sup>56</sup> In practice, this means that plants with a new heat supply must await a recommendation by the DEA, and the final decision is made by the local authority. Some observers write, "In conclusion, it is very hard nowadays to have a new large generating unit accepted politically...."<sup>57</sup> However, at present it is not profitable to invest in new power plants apart from those being subsidised to use renewable energy.

The regulation of gas affects the electricity sector both as an input and, in the longer term, as a potential competitor. The price of gas sold to gas-fired district heating plants is regulated by the Danish Gas and Heat Price Committee. The level is set in reference to the prices charged to large (over 300 000 cubic meters) industrial companies. These prices are negotiated, whereas the price of gas sold to other customers is regulated, taking into account the price of alternative fuels and the schedule of repayments for the gas pipeline system (Komgas Annual Report, 1997).

The regulation of district heating prices affects electricity because of the significant joint costs. These prices are also regulated by the Danish Gas and Heat Price Committee. Under the Electricity Supply Act, the joint costs between heat and electricity from co-production facilities shall be allocated "in accordance with reasonable economic principles." Since "reasonable economic principles" would only indicate that the charge for the jointly produced product should lie between stand-alone costs and incremental cost, this would seem to allow a wide range of cost allocations. One concern that needs to be addressed in any liberalisation is that profit-seeking energy companies would have incentives to allocate to heat as much joint costs as possible, since these costs would be recovered by regulation.

Economic regulation of the sector has been relatively informal and has had a low direct cost. However, these should be balanced against the indirect cost of foregone cost savings. The introduction of consumer choice and competition in generation will prompt more sophisticated regulation to ensure non-discriminatory access to transmission and distribution, and non-distortionary allocation of costs between heat and electricity.

### **3.4. *Taxes and subsidies***

Energy taxation in Denmark is designed to promote energy efficiency and reduced CO<sub>2</sub>-emissions while not adversely affecting the competitive position of domestic industry and electricity generators. Fuels are subjected to an energy tax and a CO<sub>2</sub>-tax. Fuels which are used for electricity generation are exempt from taxation, however, electricity is subjected to an energy and CO<sub>2</sub>-taxes. The CO<sub>2</sub> tax rate is fixed not with reference to an estimate of the marginal external cost of CO<sub>2</sub> but rather is the outcome of political considerations.

Different persons are subject to different rates of energy and CO<sub>2</sub> tax. Households pay energy and CO<sub>2</sub>-taxes on their consumption of fuels and electricity. Energy taxes are refunded to industry and commerce (except for energy used for space heating and hot water). The CO<sub>2</sub>-tax rate for industry varies according to the production process. Production processes which are considered energy intensive are subjected to a low CO<sub>2</sub>-tax rate which is 25% of the full rate. All other industrial processes are subjected to a CO<sub>2</sub>-- rate which is 90% of the full rate. Only industrial processes where the full CO<sub>2</sub>-tax would result in a tax burden higher than 1.5% of the value added and which, because of international competition, cannot pass on the tax cost to its customers are considered to be energy-intensive. The list of energy intensive processes is revised on a yearly basis.

Energy intensive companies can obtain a CO<sub>2</sub>-tax refund if they enter an agreement on energy efficiency with the Danish Energy Agency. This tax refund reduces the effective CO<sub>2</sub>-tax on energy intensive processes to 3% of the full tax rate. In return for this tax refund, the companies must commit themselves to carry out investments to improve energy efficiency and implement energy management practises. The CO<sub>2</sub>-tax regime for industry was introduced in 1996. This tax reform increased CO<sub>2</sub>-taxes on industry and commerce, while at the same time recycling the additional tax revenue by lowering labour taxes and subsidising energy efficiency investments in industry and commerce. In 1999 an evaluation of the performance of the system concluded that the environmental effects were as expected and, on this basis, the Government decided not to change the tax structure.

Electricity is subject to energy and CO<sub>2</sub>-taxes just like other fuels at the consumption level. This means that electricity taxes are the same irrespective of how it has been produced. Producers of CO<sub>2</sub>-free electricity (electricity generated by wind turbines, straw and other renewable sources) receive a subsidy compensating for the fact that the CO<sub>2</sub>-tax is also applied on the electricity from these generators. This also applies to electricity produced by decentralised gas fired CHP-plants. The system of subsidising electricity is being changed as a part of the electricity reform passed by Parliament in February 1999. Under the new law, the subsidies will be replaced in 2003 by a system of tradable green certificates, issued to the producers of CO<sub>2</sub>-free electricity.

The taxes and subsidies involved are relatively large. A sense of the magnitude of the taxes and subsidies is provided in the 1998 Annual Report from NES A/S.<sup>58</sup>

Table 9. NES A/S electricity sales, duties and indirect taxes

Item	DKK thousands
electricity sales	2 508 892
amounts collected for the State	
electricity tax	2 466 448
CO <sub>2</sub> tax	544 483
Sulphur dioxide tax	49 004
VAT	1 392 207
Total duties and indirect taxes	4 452 142
Electricity sales incl. of duties and indirect taxes	6 961 034

It has already been noted that Denmark has a complicated tax regime. Perhaps more important is the need for greater transparency so that, for example, one can ascertain that investments in energy efficiency in return for reduced CO<sub>2</sub> taxes were indeed undertaken, and that there is objective evidence that this investment would not otherwise have been made. In addition, there is evidence that payments to wind generators are excessive. The price of land suitable for wind turbines has been increasing above the value of its next best use, which means that some of the subsidies to wind turbines are being capitalised in land values. For those locations, lower subsidies would elicit the same quantity of wind turbines.

### 3.6. *Environmental regulation*

Environmental regulations and regulations that have environmental effects permeate the regulatory structure of the Danish energy sector. As a consequence, they are not addressed separately in this chapter. Among the most significant for the electricity sector are the prohibition of nuclear power plants and additional coal plants, subsidies and taxes to promote the use of wind, natural gas, and biomass, dispatch rules to favour wind and decentralised CHP, and the requirement that new generation produce also heat for district heating.

Denmark has a difficult task in reconciling its substantial international trade in electricity with its ambitious environmental goals. The Danish Government considered green taxes on fuel used to generate electricity to be the most expedient means of inducing energy efficiency, the development of CHP, and substitution towards cleaner fuels, including renewable energy. However, it felt that a “unilateral” Danish tax may distort international trade, leading to the importation of “foreign electricity produced in an environmentally harmful manner.” It felt that harmonisation of taxes on electricity production in the EU would be the best solution but, failing that, it would analyse what economic incentives and regulations might be used to achieve the desired behavioural changes without distorting international trade in electricity (Section 2, 3).

However, international trade in electricity can also provide a lower cost means of achieving the environmental goals relative to other countries. Indeed, since the purpose of the Danish CO<sub>2</sub> emissions reductions is to reduce global emissions, co-operation with other countries where the cost of emissions reduction is lower would be beneficial for both countries. Such co-operation between Denmark and Norway would save a significant sum of money on the total cost of reducing CO<sub>2</sub> emissions in these two countries. The Danish reform envisages trade of CO<sub>2</sub>-emission rights between Nordic countries. It is likely that a system of tradable CO<sub>2</sub>-emission rights will result in additional emissions reductions in Denmark because CO<sub>2</sub>-reduction costs are lower than in other Nordic countries with a small amount of fossil fuelled power plants.

## 4. THE 1999 REFORM

### 4.1. *Main Elements of the Electricity Reform*

The Folketinget (Danish Parliament) adopted on 24 May 1999 the Energy Supply Act<sup>59</sup> to implement a new framework for “consumer protection, environmental considerations and security of supply” in electricity<sup>60</sup> that introduces competition into the production and trade of electricity. The new Act is expected to come into force by the beginning of 2000 at the earliest. The main features of the new framework are:

- **Liberalisation of consumers is accelerated and extended**, with all consumers having choice of electricity supplier from 1 January 2003.
- **Production and trade of electricity are opened up to competition**: generation and “trading” companies are free of price regulation and are allowed to compete for their clients. Generation that is vertically integrated with monopoly activities is subject to the overall profit regulation of the vertical groups.
- **There is Regulated Third Party Access to the transmission and distribution grid.**
- **Incentive regulation is introduced for the monopolistic activities** : Grid and transmission companies will be subject to a new regulation based on benchmarking of costs and with profit incentives to maximise cost efficiency. The provisioning for future capital expenditures will end, with capital expenditures becoming financed through normal methods for limited liability companies. Companies with an obligation to supply retail customers will be allowed a regulated profit which will depend on their ability to lower prices.

- **The ultimate ownership structure of the sector remains largely unchanged:** there are no changes in the ultimate ownership of existing assets (*i.e.* existing property rights are respected) and changes in voting rights are not large. There are, however, significant changes in the corporate structure of the industry that will increase transparency. The share of generators and retail supply companies in the ownership of system operators, grid and transmission companies cannot exceed 15%.
- **Corporate unbundling is introduced:** licences for transmission, distribution, supply-committed retailing, and system-responsible activities may not generally be granted to the same company.
- **A new regulatory agency,** the Energy Supervisory Board, will monitor and review electricity prices and delivery conditions in the monopolistic part of the industry, as well as the revenues and costs of the vertically integrated groups, replacing the current electricity and heat and gas price boards.
- **Tax neutrality** is introduced, with the electricity companies now treated like any other limited liability company. The reform proposal does not change the rules regarding the municipal sale of electricity supply activity, according to which the proceeds exceeding a regulated rate of return on capital (*i.e.* exceeding a reasonable profit on invested capital) are effectively “taxed” at 100%.
- **Power producing companies (e.g., Elsam and Elkraft ) are assigned tradable CO<sub>2</sub> quotas** for 2000 to 2003, and will be fined for exceeding their quotas. There is the possibility that these quotas will be made internationally tradable in the future.
- **Renewable energy will be protected** by an obligation on final consumers to buy a certain percentage of renewable energy, through the purchase of Renewable Energy certificates. A guaranteed subsidy for renewable energy sources will continue until the market for renewable energy is established.
- **The public service obligations,** which are primarily related to renewable energy, are in principle maintained. However, the present obligations of generating companies are being reconsidered in the light of the effect of these obligations on their competitiveness.

This new framework bears some resemblance to the liberalised electricity sectors of Denmark’s neighbouring countries, in particular Sweden and Norway. Common points among the three countries are vertically integrated generation and distribution companies,<sup>61</sup> regulated third party access to the grid, the introduction of full consumer choice, the introduction of decentralised “bilateral” trade (as opposed to a mandatory pool) for electricity trade, and a large share of public ownership of the utilities.

However, there are also some key differences. Transmission and system operation in Denmark have not been placed under the control of an independent entity not controlled by other industry participants but largely remain under the ownership of local authorities and consumers, who also own generation companies. The corporate unbundling of transmission and system operation, while increasing transparency, does not eliminate the incentive to discriminate in the provision of transmission services, even if discrimination is not allowed (*i.e.* discrimination would constitute a violation of the Energy Act). This could constitute a serious obstacle for the development of competition in Denmark that will require close scrutiny and control by energy and competition authorities. There are also significant differences in the tools of environmental policy, with command-and-control tools playing a larger role in Denmark, and in ownership, including the requirement that consumers have a decisive influence in the governance of Danish grid companies.



All electricity consumers will have the right to choose their supplier under the new law. Choice will be gradually introduced over a period of three years (see table 10). The law also establishes default suppliers – the supply-committed enterprises - for consumers that either cannot or do not want to exercise the right to choose a supplier. All consumers will be obliged to purchase a share of Renewable Energy Certificates and will bear the cost of public service obligations.

Table 10. **Liberalisation of retail supply**

Consumers with annual consumption of, at least,	Choice of supplier from
100 GWh	Law enters into force
10 GWh	1 April 2000
1 GWh	1 January 2001
0	1 January 2003

The new regulation distinguishes among a number of separate electric activities including production, transmission, distribution, system operation, competitive retail supply, and regulated retail supply. These activities are to be carried out by production, transmission, grid, system responsible, trading, and supply-committed companies, respectively. There will be about one hundred grid companies, most of them owning generation assets, a uncertain number of supply-committed companies, about ten transmission companies, and two system responsible companies. These numbers are expected to decrease over time through consolidation of grid and transmission companies. The right to perform each activity is granted through licences that impose corporate unbundling as well as ownership, and pricing obligations on the companies. The different entities that will operate in the Danish electricity supply industry and the main regulations imposed on them are summarised in table 11 below.

The ownership structure of the sector will not immediately change under the proposed reform, but corporate unbundling is generally imposed on all six activities. Grid companies will own the distribution companies' current generation assets, as well as their transmission and distribution grids. Supply to captive customers, and system operation and other system responsibilities will be under the same ownership. The parts of the sector that would not generally be under common ownership are trading companies, which are expected to sell to liberalised customers, and production companies not now owned by distribution companies. These two types of companies will not be allowed to own more than 15% of the grid, supply obligation, or system responsible companies.

The reform restricts the voting rights in the sector. Consumers must have voting control of the grid companies, and at least one-third of votes of the supply obligation companies. At least two public representatives must be on the boards of the system responsibility companies. Grid companies that are not owned by consumers will be required to establish a committee of consumer representatives elected by the consumers in the supply area, and this committee will elect the majority of the members of the board of directors.

Table 11. Electricity entities under the 1999 reform

Name	Description of activities	Ownership/management	Regulation
Trading co.	Sell power to liberalised customers.	Corporately unbundled from all other entities except, possibly, production co. Own no more than 15% of grid, transmission, supply obligation, or system responsible co. nor have a controlling interest in the executive bodies of any of these.	Ordinary commercial co.
Supply obligation co.	Obligated to sell price-regulated electricity in supply area to captive customers and free customers not willing to buy from a trading co.	Corporately unbundled from all other entities. Own no more than 15% of grid, transmission, or system responsible co. nor have a controlling interest in the executive bodies of any of these. Consumers must have at least 1/3 of votes.	Authorisation required. Board elections regulated. Price regulated, profit allowed.
Grid co.	Operate distribution grid. Assume ownership of grid and power plants from distribution cos. Provide technical security of supply, promote energy savings and efficiency, provide information to create transparency about market conditions for all consumers.	Corporately unbundled from all other entities (1). Consumers must have voting control.	Authorisation required. Board elections regulated. Price regulated, reasonable return on capital allowed combined with benchmarking, limited profit possibilities.
Transmission co.	Operate transmission grid	Corporately unbundled from all other entities (1), (2).	Authorisation required. Price regulated, reasonable return on capital allowed combined with benchmarking, limited profit possibilities.
System responsible co.	System operation, security of supply, System co-ordination with foreign systems, Demonstration and development of prioritised electricity production, R&D.	Corporately unbundled from all other entities (2). State has first rights to any sale of shares. At least two public representatives on Board.	Authorisation required. board elections regulated. price regulated, reasonable return on capital, zero profit.

Name	Description of activities	Ownership/management	Regulation
Production co.	Generation. Obligation to supply heat at regulated prices.	Corporately unbundled from all other entities except, possibly, trading cos.  Own no more than 15% of grid, transmission, supply obligation, or system responsible co. nor have a controlling interest in the executive bodies of any of these.	Ordinary commercial co. But new entrants must jointly supply heat and electricity.

- (1) Exceptionally, the Ministry may only require accounting separation between a transmission and a grid co.  
(2) Exceptionally, the Ministry may only require accounting separation between a transmission and a system responsible co.

Price restrictions will be lifted from generation and trading activities while the rest (*i.e.*, monopolistic activities) will be subject to incentive regulation. Benchmarking of costs will be introduced for distribution and transmission companies and there is the possibility that these companies be allowed to make a profit when there are “extraordinary” efficiency improvements. The extent to which this incentive mechanism will be used still has to be determined.

A new inspection authority – the Energy Supervisory Board – will replace the Electricity Price Committee and the Gas and Heat Price Committee. The main task of the Board is to regulate tariffs and prices of system operation, transmission and grid services and supply, under a general framework established by the Ministry. The board will amend prices and delivery conditions whenever they are found to be unreasonable or to result in an environmentally or economically inappropriate utilisation of energy. The Board is an autonomous body consisting of a Chairman and six other members appointed by the Minister for Environment and Energy for a period of four years and it is endowed with extensive powers to request information and to enforce sanctions for non-compliance, if necessary. The Ministry can delegate other regulatory tasks to the Board.

The Ministry for Environment and Energy will retain key regulatory powers in the sector including those linked to licensing, authorisation of new production plants and transmission lines, setting rules on environmentally benign electricity production and definition of public service obligations. The new legislation does not set detailed rules leaving to the Ministry the definition and implementation of policies; plans are to generally continue existing policies.

In the future, Danish electricity companies are to be liable to general taxation. A distribution tax on electricity grid services will also be introduced. However, the present rules concerning sales by local authorities of electricity supply companies are not to be amended.

The promotion of Renewable Energy (RE) and other environmentally benign energy sources is a main goal of the new legislation. Tradable RE certificates will be assigned to RE producers and consumers will be obliged to purchase certificates in proportion to their electricity consumption. Until this market mechanism is implemented, subsidies to RE will be financed through a surcharge on electricity prices. In addition, subsidies for environmentally benign small-scale production plants will continue unchanged and grid and system responsible companies will be obliged to purchase electricity from them. CO<sub>2</sub> emission quotas for electricity production have been established for the period 2000-2003, requiring emissions to decrease from 30 m tons to 23 m tons in 2000. In the period 2000-2003, emissions are required to decrease 1 m tons yearly. These overall caps will result in specific limits being set for individual electricity producers, that will be fined DKK 40 per ton of CO<sub>2</sub> in excess of the permit. The act allows emission rights

to be traded nationally and envisages that quotas may become internationally tradable in the future. Other environmentally motivated regulations, including new energy saving legislation, and the detailed rules of the RE certificates market have not been adopted as of August 1999.

## **4.2. Critique of the reform**

### *General assessment*

The proposed reform has the potential to improve the performance of the Danish electricity supply industry. The new framework opens the electricity market to all electricity consumers and allows competition in generation and trade, which are key requirements for the development of competition and improved performance. In addition, new regulations on corporate unbundling and pricing will increase transparency and provide the basis for a more efficient regulation of the monopolistic segments of the industry.

In the short to medium term, a number of structural and regulatory barriers inherited from the previous regulatory regime will slow down the development of effective competition within the industry. Significant obstacles to the development of competition include:

- The vertical integration of electricity companies.
- The continuation of existing marketing agreements and cross-ownership with foreign competitors.
- The various constraints imposed on ownership rights.
- Continuing requirements on generation such as the obligation to jointly supply electricity and heat or the controls on the choice of fuel.<sup>62</sup>

Given these constraints, it is clear that significant change will depend largely on the entry and subsequent expansion of new entities, either domestically or through international trade. In this regard, Denmark has the advantage that local supply companies are independent from foreign generators which favours competition.

There remains large scope for manoeuvre in the adopted legislation that could accelerate the development of competition and increase efficiency gains accordingly. For example, the economic regulation of the sector has not been made precise. Neither the market rules for “green” electricity nor the extent of public service obligations are fully specified. The speed at which competition develops and the ultimate impact of reform will largely depend on how these and other details of the reform program are specified. There are three areas in which the detailed development of regulation will have a large impact on the prospects for effective competition. First, eligible customers must, in practice, be able to buy power from foreign generators. This means that all the complementary products—notably transmission and system operation—must be provided in a non-discriminatory manner. Since transmission will have the same owners as most generation, the legal obligation to provide non-discriminatory access at reasonable prices must be strictly monitored and enforced. Second, the foreign generators must compete for Danish customers. Marketing agreements and cross-ownership with Danish incumbents and limited transmission capacity reduce the foreign generators’ incentive and ability to compete. Without effective competition from abroad, Danish consumers’ “freedom to choose” is severely constrained. Third, existing barriers to interconnectors maintained by neighbouring countries reduce competition in the Danish market.

In addition to regulatory reform, the incorporation of Denmark to the Nordpool has an impact on the development of competition in the Danish market. However, the size and scope of this impact may be, at least initially, limited. The low prices set in Nordpool since the summer and fall of 1999 (relative to long run costs of Danish electricity) have a clear effect on Danish exports, which are paid Nordpool spot prices, but the expected positive impact on the prices paid by Danish consumers may not be immediate. Exports only represent a fraction of Danish electricity production over these months and revenues to cover fixed costs may come from domestic sales. As argued above, a significant price differential has existed, at least until very recently, between Swedish and Danish prices. The market situation is still volatile due to the risk of abuse of dominant position by those market players who control the links to Norway. A precise assessment of the impact of Denmark's incorporation to Nordpool will have to wait until a longer observation period (*e.g.*, including other demand conditions) and information on the prices actually paid by Danish consumers become available.

### *Vertical unbundling*

The ultimate ownership structure of the sector will not change immediately even though the corporate structure will be reformed to separate into different companies the different functions along the vertical supply chain and, in this way, increase transparency. The grid companies will assume the ownership of most existing generation and grids, thus maintaining the vertically integrated structure of the industry.

The corporate unbundling of activities introduced in the new legislation will increase transparency but is not enough to eliminate the incentive to discriminate by the vertically integrated companies against their competitors in production and trade activities. Corporate unbundling as required in the new Danish legislation will lead to the creation of separate legal entities, and therefore separate accounts, for each of the activities involved but allows companies to share their management and staff, and does not affect the flow of information between them. Note, however, that it would be a violation of the Energy Law if the system-responsible company violated confidentiality of commercial information (para. 28(2)).

A combination of regulation and vertical separation of utilities can be used to counter discrimination in transmission access. There are tradeoffs between regulation and degree of vertical separation. Where there is less vertical separation, there is a need for greater regulation, and vice versa. These two policy tools can be used to reduce the incentives and the ability to discriminate. Divestiture, that is, separation of ownership of generation from transmission, eliminates incentives to discriminate. Also, the ability to discriminate can be reduced to varying degrees by accounting, corporate, functional and operational separation.

Ownership separation of generation, transmission, distribution, and retail supply would create the most effective competition in Denmark. This has been noted by the Danish Competition Authority. If ownership separation is not feasible, then operational separation strictly enforced may also be an effective remedy against discrimination. Operational separation places operation of and decisions about investment in the transmission grid under the responsibility of an entity that is fully independent of the owner(s) of generation; ownership of the transmission grid remains with the owners of generation. Operational separation is, however, more costly to administer than ownership separation because it requires extensive regulatory oversight to be effective.

Ownership links between distribution and retail supply companies may also be particularly damaging as they create opportunities for both cross-subsidisation and discrimination against competitors. In addition, the present integration may distort competition if it deters customers from switching to a new supplier. Customers may be misled to believe that switching supplier might lead to a lower reliability level.

### *Governance*

The grid companies will be the lynchpins of the sector for the foreseeable future as they are taking on the ownership of most of the existing physical assets in the sector. Hence requiring consumers to have voting control of the grid companies implies that this reform would not change the governance of the sector. As a result, the management of the companies is distorted. Managers are required to give consideration to a complex set of objectives, some of which are external or even unrelated to the activity of the company. Such objectives can be more effectively managed by the appropriate political institutions (e.g., government or the municipalities) than by commercial companies. In addition, the superposition of objectives inevitably weakens the incentives of managers for cost minimisation and efficiency. Finally, private investment, which has an important disciplining role for managers, will not be a factor in grid companies, if ownership does not bring with it commensurate voting rights or the right to keep profits.

### *Incentive regulation of monopoly segments*

In line with “best practices” for network regulation increasingly applied around the world, the new Danish legislation introduces incentives in the regulation of distribution and transmission grids. Incentives –in the form of allowing the most efficient companies to make profits- will be implemented through yardstick competition or benchmarking. These measures are also intended to avoid cross subsidisation. Under the new system, the regulator will evaluate each grid company’s efficiency and planned investments. The regulator will construct key measures, such as for capital investment and for operation and maintenance. It will use these measures to compare each company’s efficiency against the others. Based on these measures, individual companies will have efficiency improvement targets in addition to sector-wide efficiency targets. One estimate of the average potential efficiency gain is about 30%. In addition, cost oversight is planned to be more strictly maintained, with tighter oversight of “necessary costs”.

The introduction of incentive regulation is a step in the right direction. To be effective, the increased regulatory oversight will require that the regulator has many more resources and to be much more active than it has been to date. Under the present regulatory system, the regulator allows only revenues to cover “necessary costs” (and provisions for future investments) so in principle there is already regulatory oversight of investments and other expenditures. The new legislation provides the regulator with significant powers to require information from companies thus allowing the regulator to actually play this enlarged regulatory role.

### *Entry into generation*

Substantial regulatory barriers to entry into generation will remain in place including those erected by the obligation to jointly supply heat and power and the constraints on the choice of fuel by generators. As a consequence, new entry is not likely to have a significant role in the development of competition. Instead, increased competition will have to come from foreign generators. Consideration should be given to whether trade will be enough to make competition workable within the Danish electricity market. As discussed before, it is still unclear to what extent foreign competition through the NordPool is already pushing in this direction. One factor that may help to make foreign competition effective is that retail supply companies in Denmark are not controlled by the new (foreign) competitors therefore limiting the degree of effective vertical integration of the industry.

Options to reduce regulatory barriers to entry should be considered. The impact of regulatory barriers under the current market conditions of overcapacity and relatively low prices in the NordPool may be small. However, even in these market conditions it is possible that new and more efficient investment could profitably displace some existing assets. Furthermore, in the longer term, as market conditions evolve, the impact of regulatory barriers to entry may be expected to increase. To the extent that these regulatory barriers to entry are environmentally motivated, their impact should also be assessed in the context of the review of environmental policies recommended below.

#### *Pricing and access to the transmission grid*

Non-discriminatory transmission access is essential for the new Danish electricity system to work. The intention seems to be to rely on foreign generators to provide competition to the present domestic firms, and liberalised customers who contract with these foreign generators will be using the transmission system. A strong regulatory oversight of Eltra and the equivalent in the Elkraft area is needed to ensure that these companies do not abuse their monopoly positions.

Undistorted transmission pricing is also essential for competition to develop. The Energy Supply Act establishes that there will be postage stamp transmission tariffs similar to those in the other Nordic countries. Tariffs will be set for each of the transmission companies with a view to cover their costs.

An efficient transmission pricing system for cross-border trade is also an important requirement for the development of effective competition. On the other hand, some forms of transmission pricing (*e.g.*, distance dependent tariffs) can be an important barrier to competition. Abolishing such barriers obviously requires a co-ordinated action by all the trading partners in the area.

#### *Supply obligation companies*

The regulation of supply obligation companies, while intended to provide protection to electricity consumers, also has a large impact on the development of the liberalised segments of the market. The regulation of supply obligation companies, including the setting of tariff levels and structures and the rules concerning the purchase of electricity from jointly-owned production companies, has to be carefully designed to avoid introducing a bias against new entrants in production and trading. The experience of other reforming countries, notably the UK, in the regulation of public electricity suppliers shows the need to prioritise this task.

New entry will be discouraged if the level and structure of end-user tariffs is inappropriate. Tariffs protect consumers against abusive pricing. However, if tariffs for the liberalised consumer groups are too low, entry by competing generators will be discouraged since consumers will prefer not to switch to the market. Setting the regulated tariff to provide consumer protection without subsidising any consumer groups is a delicate task.

In the longer term, *i.e.* from January 2003, as consumer choice is extended to all consumers, the role of supply obligation companies may wither to supplying only costly-to-supply, low-margin consumers; if so, the increasing average cost of supply will need to be reflected in the regulated tariffs.

New entry into production will be discouraged if supply obligation companies do not have the right incentives to buy the cheapest electricity available. Supply obligation companies may have an incentive to buy from their own vertically integrated production companies, even if this is not the minimum cost alternative, and pass the extra cost on to the consumers via the regulated tariff. The ability of the regulators to avoid self-dealing is limited by the limited availability of information on generation

costs. However, the unbundling of companies and the transparent price information provided by the spot market are efficient means of producing information for customers as well as for the regulator. In this way, careful oversight and benchmarking among supply obligation companies can improve the quality of the available information. Comparing the energy costs of supply obligation companies with energy costs of trading companies can provide another performance check.

One way to provide incentives for Elsam and Elkraft to reduce generation costs would be to require supply obligation companies to procure power at the best available price. This might involve long-term bilateral contracts with foreign or domestic generators, or buying from NordPool, or a combination of contracts. This requirement would, of course, require careful oversight by the regulators; for example, it is difficult to “price” the insurance of owning one’s own generation.

### *Independent regulation*

The economic regulation of the monopolistic activities will be conducted by the Energy Supervisory Board, an independent regulatory body. The Ministry will retain key regulatory powers, particularly those related to environmental policy and security of supply. The Ministry will be responsible for licensing, authorising new production plants and transmission lines, authorising significant changes to existing assets, setting rules on environmentally benign electricity production and defining public service obligations. The intention seems to be to largely maintain the wide array of regulations affecting entry even though specific non-discriminatory criteria will be developed on the basis of the new act. The implications of regulatory barriers for competition are discussed above.

Other OECD countries have independent regulators, including Australia, Finland, Italy, Spain, the United Kingdom and the United States. While specific arrangements differ in each country the main features of independent regulation are: complete independence from the regulated companies, a legal mandate that provides for separation the regulatory body from political control, a degree of organisational autonomy, and well defined obligations for transparency (*e.g.*, publishing decisions) and accountability (*e.g.*, appealable decisions, public scrutiny of expenditures).

A greater reliance on independent regulation could help reduce regulatory barriers, promote entry and accelerate the development of competition in the Danish electricity supply industry. Independent regulation is presently limited to the economic regulation of the monopolistic activities but its scope could be expanded within the existing regulatory framework. In particular, the Ministry for Environment and Energy can delegate some of its powers to the Energy Supervisory Board while, at the same time, may reduce its direct involvement in the industry. In practice, since many regulations are environmentally motivated, the delegation of regulatory responsibilities to a “technical” regulator (*i.e.* one with a specific ESI perspective) is not being considered by the Danish government. Another way in which regulatory barriers to entry can be diminished within the existing regulatory framework is by increasing the use of market based mechanisms whenever feasible, as discussed below.

### *Environmental policy*

Against the background of the interventionist approach used to date, planned reforms aim to introduce some market-based mechanisms that will increase the cost effectiveness of Danish environmental policy. The Energy Supply Act introduces a tradable RE certificates market thus eliminating direct subsidies for renewable energy production. Tradable permits have an advantage over quotas in that they allow the equalisation of marginal cost across consumers and spur innovation and new technologies. For example, most wind generation is now located in western Denmark. If wind generation is cheaper in the west, then requiring, say, Copenhagen residents to purchase permits for wind generated in the west,



rather than quotas for wind generated in the east, would be more cost effective. Current policies to subsidise specific windmill technologies are not consistent with a market-based approach and could reduce innovation in green energies in the long term.

Further improvements in cost effectiveness could be achieved in a number of ways. For instance, introducing internationally tradable permits as encouraged by the new law would further reduce costs by equalising the marginal cost of reducing emissions across producers in a larger geographical area, thus reducing total costs. In addition, this would reduce the need for command-and-control policy tools including the dismantling or reduction of subsidies to prioritised but non-renewable energy production and, possibly, the elimination of some regulatory entry barriers (*e.g.* certain constraints on fuel choice). Another significant benefit would be the increased transparency of a simplified regulatory framework.

Public service obligations (PSOs) are to be maintained in the new regime. One important principle is that accounting separation between the PSOs and commercial activities requires strong monitoring and, therefore, additional regulatory resources because the utilities will have incentives to load joint costs onto the PSOs, where they are assured of compensation, rather than onto commercial activities. Well-enforced separate accounting could also allow a comparison of the costs and benefits of the PSOs.

#### *Transition issues (I): Allocation of transmission rights*

A significant transition issue in Denmark is how to move from the current assignment of international transmission rights to an allocation mechanism that ensures competition-promoting transmission access. Consider the 25-year agreement under which Statkraft, Elsam, and PreussenElektric have the right to almost all the transmission capacity from Norway to Jutland. If this agreement remains in place, then competition from other Norwegian generators for Danish customers is almost foreclosed. Simply taking away the capacity would cause severe legal problems and would discourage future sunk investments for fear that they, too, might one day be taken away. If competition from other Norwegian generators really reduces prices in Jutland, then in theory electricity consumers in Jutland should be able to buy the transmission rights from the incumbents at a fully compensatory price. However, it is difficult to form a voluntary coalition of consumers to make this transaction. The Anderson study shows that the theoretical identity of consumers and owners is not enough to resolve this problem. The regulation of access terms and conditions is not a solution, as there is almost no un-contracted cross-border capacity to which access could be granted available for the next two decades.

There is no easy solution, but the issue needs to be addressed if the reform is to lead to competition from foreign generators. The EU as a whole, in the context of the implementation of the Directive on the internal electricity market, is currently discussing proposals to ensure efficient and harmonised international transmission access. The outcome of this discussion will undoubtedly frame the Danish approach. In addition, EU transmission companies have been asked to make proposals for the efficient regulation of international transmission. This procedure consisting of letting market participants to take the lead, may also be useful to address the Danish case.

Some significant first steps have been taken to address these issues. Today there is a monthly auction of available capacity on the Danish/ German border. Capacity which is not used is offered on a day to day basis. From January 1, 2000, the available capacity on the Danish/ German border will be allocated on a daily basis. Also, NordPool rules apply to exchanges with NordPool member countries. However, these rules do not affect previous agreements.

#### Box 4. Contracts spanning regulatory regimes

Other countries introducing competition into their electricity sectors have addressed the issue of existing contracts that served to block competition or the flow of benefits of liberalisation to final consumers.

In Italy, the competition authority found that contracts offered to the largest customers by the incumbent, ENEL, constituted abuses of a dominant position because they were likely to limit production and restrict market outlets. The two offensive clauses extended the period of exclusive supply and established for ENEL the right of pre-emption, in cases where one of its customers receives a more advantageous offer from a competitor. (Italian Competition Authority. Press releases of 20 November 1998 and 19 April 1999).

In Norway, some long-term exclusive contracts between distribution/supply companies and generators were found, by the Norwegian Competition Authority, to have the effect of preventing some small customers from actually benefiting from the reforms. After this view was communicated to the parties, essentially all these contracts were re-negotiated.

#### *Transition Issues (II): Stranded costs and stranded benefits*

Stranded costs are those unamortised costs of prior investments or ongoing costs because of contractual obligations, prudently incurred under the prior regulatory regime, that will not be recovered under the new regime. Stranded costs and benefits will be a significant issue only if prices decline significantly in the near term or if new entrants displace existing but less efficient generating assets. For instance, lifting constraints on fuel choice or allowing electricity and heat to be produced separately could facilitate entry of more efficient generators. Effective foreign competition could have a similar effect. Thus, reform plans have to identify mechanisms to deal with stranded costs. Such mechanisms should provide incentives for incumbents to mitigate stranded costs, to measure them accurately and to assign their recovery in a fair and competitively neutral way.

The change in the status of generation from non-profit to profit-seeking does not by itself result in a change in the value of the companies (*e.g.* a “windfall profit” or loss). According to standard accounting rules used in Denmark, non-profit companies are valued at book value of the equity. That is, the companies are valued according to the depreciated historical cost of their assets. By contrast, profit-seeking companies are valued at market value. That is, they are valued according to beliefs about their future cash flow. Consequently, changing the status of the electricity sector from non-profit to for-profit changes the accounting value of the companies. By itself, this does not change the real, economic value of the companies; there is no “windfall profit” from the transition. Instead, the apparent “profit” or “loss” (if the market value is less than depreciated historical cost) is a figment of accounting conventions.

By contrast, a change in regulation *can* change the real, economic value of the companies. For example, if a price cap were lowered, then profits would fall and the market value of the companies would fall.

## 5. CONCLUSIONS AND RECOMMENDATIONS

The electricity sector in Denmark is at the beginning of a transition. A framework for reform was adopted by the Danish Parliament in 1999, but some key aspects of the regulatory framework still have to be developed.

## 5.1. Conclusions

Denmark can expect substantial rewards from reforming its electricity system. Increased integration in the Nordic electricity market will result in cost-efficiency gains that would not be achievable in isolation given the small size of the Danish electricity systems. Increased integration will also provide lower prices as Danish electricity prices converge to the average of the region. At the wholesale level, competition has already resulted in significant price reductions. Reforms in 1998 and 1999 have already resulted in significant changes in the organisational structure, and significant price reductions in the wholesale market in the western part of the country, which has been integrated into the NordPool electricity market.

If the Danish electricity sector were reformed in line with reforms in other Nordic countries, economic efficiency in the electricity sector could increase by at least 20 %. DKK 2bn will be used to improve the state budget through higher taxes and making electricity consumers pay subsidies to renewable energy. Market liberalisation would slightly increase the price in other Nordic countries. It would produce a gain of DKK 7bn annually (increasing to DKK 13bn in 2020), with Denmark the largest beneficiary. Furthermore, these gains can be obtained quickly and at low cost given that existing physical links with neighbouring countries are strong.

The new legislation introduces two key building blocks of a competitive electricity market: Denmark plans to grant all consumers access to the market by the end of 2002 and to allow competition in generation and trade. However, stronger reforms are needed in some areas.

First, the single most important threat to the effective integration of the Danish market consists of a number of agreements and cross-ownership between the Danish generators and foreign generators that may block transmission capacity and result in asymmetric transmission access. Even if some significant first steps have already been taken to address this issue and although there is no easy solution to deal with it, options need to be considered to ensure that there is effective international competition in the Danish electricity market.

Second, corporate unbundling will increase transparency and promote non discrimination but falls short of changing the vertically integrated structure of the industry. Divestiture of generation from transmission and supply would eliminate incentives for monopolies to discriminate in favour of higher-cost generation with the same owners, thus reducing regulatory oversight. If ownership separation is not feasible, strictly enforced operational separation may help to prevent discrimination at a somewhat higher cost for the regulator.

Third, high regulatory barriers to entry may persist. Increasing the powers of the Energy Supervisory Board and reinforcing its means and independence would help to reduce regulatory entry barriers and, more generally, would help to adapt the institutional framework to the needs of a market open to competition. In order to promote private sector investment in the electricity supply industry, conditions of competitive neutrality should be in place, that is, regulation should be applied equally regardless of the ownership of the utilities. While competitive neutrality is indeed a key objective of the reform, ensuring it requires a re-examination of the historical role of the municipalities in the industry.

Strong Danish environmental commitments offer challenges to the reform. A key challenge is to make environmental policy cost effective and this requires even more emphasis on market-based mechanisms to implement environmental policy. The reform approach outlined so far is cautious. It introduces some market tools – the RE certificates market – while maintaining many existing tools unchanged (*e.g.*, requirements on the fuel mix). A comprehensive review of environmental policy tools in the new competitive setting would help to improve the effectiveness of regulation. The review would help

both to identify opportunities to introduce market-based mechanisms, replacing existing mechanisms, and to eliminate mechanisms that are superfluous. It must be acknowledged that developing these market mechanisms is a difficult task given the limited experience accumulated so far. Another key challenge, certainly not unique to Denmark but highlighted by the importance of Danish environmental policy, is to increase the transparency of the costs and benefits of environmental policy. The costs of environmental policies to the Danish economy and the value of emissions reductions are largely unknown. Even if precise cost-benefit assessments are difficult to establish, estimates can be useful both to ensure the effectiveness of policy decisions and to increase public awareness of the trade-offs involved.

Reform also creates opportunities for Danish environmental policy. The commitment of OECD countries to environmental protection is growing and there is also growing acknowledgement of the importance of market-based mechanisms to achieve environmental goals. The EU is seeking to develop policies to meet the Kyoto commitments. There is a clear understanding at this stage that the completion of a liberalised EU internal electricity market has to be matched by some harmonisation of environmental policy approaches. Nevertheless, there is some way to go to reach a consensus on how to harmonise. This is a challenge not just for Denmark but for all of Europe but Denmark, with its strong commitment and accumulated expertise, has a unique opportunity to set the pace in the development of new harmonised environmental policies within the EU and elsewhere.

In summary, this report commends the decision to reform the Danish electricity supply industry but underlines that additional measures are needed for reform to succeed. Key priorities should include reviewing the barriers to international trade, considering options to improve the vertical structure of the industry, reinforcing independent regulation, increasing the incentives for efficiency in the regulation, and further developing market-based mechanisms for environmental policy in conjunction with trading partners. If these issues are adequately addressed, the benefits of reform for the Danish economy will be substantial.

## **5.2. Recommendations**

The recommendations of this study pursue five complementary goals: create conditions for effective competition, protect consumers and ensure that consumers reap the benefits of reform, reinforce independent regulation, increase the cost effectiveness of environmental policies, and review the effectiveness of reforms.

### *Create conditions for effective competition*

**Vertical Separation:** Effective competition requires non-discriminatory access to essential networks. Non-discriminatory access, as required in the new legislation, is supported by the separation of the potentially competitive activities from the networks, transparent access conditions and, where common ownership is retained, vigilant and effective independent regulation. Therefore, reinforce vertical separation along the electricity supply chain, particularly as regards generation. Separate ownership of generation from transmission and from retail supply, and from system operation should be encouraged; and, in addition, requiring ownership separation of generation should be considered.

**Transmission:** In addition, to ensure non-discriminatory access to the network, develop as planned a methodology and set cost reflective transmission tariffs and terms of access that do not discriminate between suppliers and are not distorted by the fragmented ownership of the transmission grids.

**Trade:** Effective competition also requires a fluid market structure with an adequate number of players. The structure and small size of the Danish electricity market implies that foreign competitors are essential to reduce market power. Therefore, ensure efficient and non-discriminatory access to international transmission links. In particular, consider options to eliminate the anticompetitive effects of agreements and cross-ownership between the Danish generators and foreign generators. Consider the viability of developing transmission links across the Great Belt to connect the Elsam and Elkraft areas.

**Competition law:** The application of competition law to the electricity supply industry has to be strengthened to prevent collusion, abuse of dominance, or anticompetitive agreements, mergers, and long-term contracts that risk frustrating reform. Potentially anticompetitive agreements, joint ventures, long-term contracts for transmission capacity or to supply large end-users or generators should be identified and prevented.

**Stranded Costs and benefits:** Stranded costs and stranded benefits must be addressed equitably and in such a way as not to distort competition. Therefore, develop a comprehensive plan to resolve stranded costs and stranded benefits that is transparent and equitable, and does not hinder entry or subsequent competition.

*Protect consumers and ensure that consumers reap the benefits of reform*

**End user tariffs:** Ensure that end-user tariffs are cost reflective. In particular, set tariffs so as not to discriminate between customers remaining on tariffs or opting to use the market, avoid artificially reducing the incentives of consumers to switch to the market, and apply homogeneous criteria across the different distribution areas.

**Small consumers:** Accelerate, as planned, end-user choice of supplier and consider measures to ensure that all electricity consumers have effective choice. Among the measures that may help to promote effective choice by all consumers are: consumer education programs; load-profiling for small consumers; and standards, norms and programs to facilitate the introduction of sophisticated meters.

**Supply obligation companies:** Consumer protection, mainly provided through regulated tariffs imposed on the supply obligation companies, needs to be reinforced during the transition to competition. To ensure appropriate tariff levels, the costs of the supply obligation companies must be as low as possible. Therefore, identify options to promote cost efficiency in the near term such as requiring supply obligation companies to buy electricity at the lowest available price and repealing provisions requiring grid companies to buy from their own production companies.

**Governance:** Consumer influence on grid and supply obligation companies may not be providing effective consumer protection, while this influence may generate a number of distortions. Therefore, identify options and provide consumer co-operatives and municipally owned electricity companies with governance structures that ensure that decisions are based on commercial criteria. Provide an accounting system that makes their objectives and achievements more transparent.

**Costs of monopolistic activities:** Introduce, as planned, regulatory incentives for cost reduction, such as through price caps or yardstick competition, and ensure that the incentives are effective. In particular, consider whether rewards provided to companies for improved performance are large enough and whether they are allocated to the appropriate actors or entities.

*Reinforce independent regulation*

**Energy Supervisory Board:** Reinforce the authority and independence of the Energy Supervisory Board, as well as the transparency of its decisions. Close relations between the competition authority and the new sector regulator should be encouraged. Increase, as planned, vigilance over the “necessary costs” of supply obligation, grid and transmission companies and ensure that the Energy Supervisory Board has enough resources to carry out this task.

*Increase the cost effectiveness of environmental policies*

**RE certificates:** Proceed as planned with the establishment of a “renewable energy certificates market”, consider designs that do not discriminate among technologies and work with trading partners to encourage the development of an international market.

**CO<sub>2</sub> emissions:** Encourage trading partners to develop an international market for controlling emissions of CO<sub>2</sub> to ensure that emission control is achieved in the most efficient way.

**Other policies:** Review existing environmental policies to identify areas in which: market-based mechanisms could be introduced; redundancies exist so that policies can be consolidated; or rules (*e.g.* for granting tax breaks and subsidies) could be made more transparent and verifiable so that the effectiveness of policies is increased.

*Review the effectiveness of reform*

**Overall review of reform:** Review the reform some time (*e.g.* two to three years) after its implementation to judge its effectiveness, with particular reference to: the achievement of effective competition, the effectiveness of the new regulatory system and the effectiveness of environmental policies.

## NOTES

1. Danish Energy Agency, Energy 21, <http://www.ens.dk/e21/e21uk/underkap/11.htm>.
2. Danish Energy Agency.
3. Danish Energy Agency.
4. Danish Energy Agency (1998), *Combined Heat and Power in Denmark*, p. 20.
5. Danish Energy Agency (1995), Denmark's Energy Future, December, p. 56.
6. Elsam 1998 Annual Report, Section 3.3.6.
7. Competition Council report on electricity reform, Section 3.4.3.
8. Danish Energy Agency (1998), *Combined Heat and Power in Denmark*.
9. Directive 96/92 of 19 December 1996 concerning common rules for the internal market for electricity, OJ 1997, L 27/20.
10. Danish Energy Agency, Energy 21, <http://www.ens.dk/e21/e21uk/underkap/11.htm> and Grohnheit, Poul Erik and Olsen, Ole Jess (1997).
11. Grohnheit, Poul Erik and Olsen, Ole Jess (1997), p. 22.
12. Elsam's web site, <http://www.Elsam.dk>.
13. Denmark adjusts its emissions data for temperature variations and for trade in electricity because Danish electricity trade fluctuates considerably from year to year depending on the availability of hydropower in Norway and Sweden. Typically, Denmark exports electricity to its Nordic neighbours when water reserves are low and imports it when reserves are large. This pattern of trade has existed for decades.
14. Press release, December 18, 1998; Grohnheit, Poul Erik and Olsen, Ole Jess. "Organisation and Regulation of the ESI in Denmark," Risø-I-1208(EN), Risø National Laboratory, Roskilde, December 1997.
15. More specifically, Elkraft pays its constituent generating companies a fixed amount for provision of new investment and a variable amount for fuel and other variable costs. The constituent generating companies buy electricity from Elkraft at a common price.
16. Danish Energy Agency (1995), Denmark's Energy Future, December, p. 144-5.
17. Economic Council, Danish Economy (1997), Chapter IV: "The Electricity Supply Industry in Transition" at < <http://www.dors.dk/english/index.htm> >, English summary, Autumn, p. 24.
18. Elsam's web site, <http://www.Elsam.dk>.
19. Eltra's web site, <http://www.Eltra.dk/>, Excerpts from Environmental Report 1997.
20. Eltra's web site, <http://www.Eltra.dk/>.

21. After West Denmark entered the Nordpool, the partners in this agreement agreed to inform Nordpool daily about unused and therefore available capacity but the exchange of electricity takes place only when there is a certain price difference between the two areas (currently about 3 ore/kWh). The EU Commission is currently investigating this agreement; “Danish Wind Energy Co-operatives Part 1” by Flemming Tranæs, Chairman, Danish Wind Turbine Owners Association, p. 17 for 1995.
22. Elsam’s Annual Report 1997, p. 17 and Elsam 1998 Annual Report, p. 18.
23. Statkraft <[http://www.statkraft.no/english/content/shw\\_article\\_frame.asp?s\\_id=113&a\\_id=619](http://www.statkraft.no/english/content/shw_article_frame.asp?s_id=113&a_id=619)>.
24. Notes on The Energy Supply Bill, Act no. 375 of 2 June 1999, On Section 70, General Notes 2i) and 2.
25. Further, since CHP and renewable energy are considered by Denmark to be environmentally benign, Denmark considers it “vital that there should be no uncertainty about the large basic investments in the expansion of natural gas and the CHP projects nor about the investments in renewable energy.”
26. Amundsen, Eirik S. and Bergman, Lars. “The Performance of the Deregulated Electricity Markets in Norway and Sweden: A Tentative Assessment.” Working Papers in Economics, No. 0798, Department of Economics, University of Bergen.
27. Vattenfall’s web site, <http://www.vattenfall.se/international/about/index.wbs>.
28. Amundsen, Eirik S. and Bergman, Lars. “The Performance of the Deregulated Electricity Markets in Norway and Sweden: A Tentative Assessment.” Working Papers in Economics, No. 0798, Department of Economics, University of Bergen.
29. Introducing Statkraft [http://www.statkraft.no/english/content/shw\\_article\\_frame.asp?s\\_id=116&a\\_id=680](http://www.statkraft.no/english/content/shw_article_frame.asp?s_id=116&a_id=680).
30. Preussenelektra’s web site (1999), <http://www.preussenelektra.de/index.pl?s=/30/30.stm>.
31. Amundsen, Eirik S. and Bergman, Lars. “The Performance of the Deregulated Electricity Markets in Norway and Sweden: A Tentative Assessment.” Working Papers in Economics, No. 0798, Department of Economics, University of Bergen.
32. Press release, September 24, 1998 at Elsam’s web site, <http://www.Elsam.dk>.
33. Oslo Energi Annual Report 1997, [http://www.oep.no/annual\\_report97/s2.html](http://www.oep.no/annual_report97/s2.html).
34. Introducing Statkraft, [http://www.statkraft.no/english/content/shw\\_article\\_frame.asp?s\\_id=116&a\\_id=680](http://www.statkraft.no/english/content/shw_article_frame.asp?s_id=116&a_id=680).
35. Preussenelektra’s web site (1999), <http://www.preussenelektra.de/index.pl?s=/30/30.stm>.
36. Preussenelektra’s web site (1999), <http://www.preussenelektra.de/index.pl?s=/30/30.stm>.
37. Eltra’s web site, <http://www.Eltra.dk/>, p. 12.
38. Press release, September 14, 1998 at Elsam’s web site, <http://www.Elsam.dk>.
39. Press releases, September 14, 1998 and December 15, 1998 at Elsam’s web site, <http://www.Elsam.dk>.
40. Preussenelektra’s web site (1999), <http://www.preussenelektra.de/index.pl?s=/30/30.stm>.
41. Grohnheit, Poul Erik and Olsen, Ole Jess. “Organisation and Regulation of the ESI in Denmark,” Risø-I-1208(EN), Risø National Laboratory, Roskilde, December 1997, p. 19.



42. NordPool's web site, <http://www.NordPool.no/eng97/index.htm>.
43. Dansk Naturgas A/S (DANGAS) is the monopoly owner of the natural gas pipeline network. It also has the monopoly on natural gas transport (in the national pipeline), storage, imports, and exports. The five regional distribution companies, with non-overlapping service areas, are owned by the local councils in the respective areas. They work together in an association, KOMGAS. DANGAS sells gas to the five regional distribution companies, to the large central cogeneration plants and large commercial clients. Decentralised cogeneration plants with outputs over 35 MWe are joint customers of the regional natural gas companies and DANGAS. The regional companies distribute and sell gas to district heating plants, decentralised cogeneration plants, block heating centres, large and small businesses, industrial cogeneration plants and domestic households. The price at which the regional distribution companies buy from DANGAS is negotiated; the regional distribution companies agree on prices charged to end-users and on the geographic regions supplied, and this agreement is approved by the Minister for Environment and Energy, (Sect. 2.3 and 6.2.1, 6).
44. Competition Council report on electricity reform, Section 2.4.
45. Andersen Management International A/S: Report on the connections between regulation and organisation of distribution companies and their protection of consumers' interests – Increased consideration of consumer interests: From unregulated monopoly of supply to regulated competition? May 1997. The report was written for the Ministry of Energy and the Environment Energy Authority.
46. Grohnheit, Poul Erik and Olsen, Ole Jess (1997), "Organisation and Regulation of the ESI in Denmark," Risø-I-1208(EN), Risø National Laboratory, Roskilde, December, p. 12.
47. Pricing is described below.
48. Danish submission to IEA In-Depth Review, description of recent developments in energy policy, 1996 and 1997.
49. Energy 2000 (1990), p. 35.
50. The tax regime for reducing CO<sub>2</sub> emissions is complicated by the global nature of greenhouse gases. The social cost of CO<sub>2</sub> emissions is independent of the location of the emitter. If there were a single tax jurisdiction, the CO<sub>2</sub> tax would be identical for all persons and the amount would equal the marginal social cost of CO<sub>2</sub>. However, this social cost has not been calculated; rather, in Denmark a value has come out of a political agreement. Where there are multiple tax jurisdictions, and some emitters can move to lower tax jurisdictions and emit there, then the optimal tax policy would charge those who are likely to flee a lower tax rate than others, or receive a lump-sum payment for not moving. Such a "negotiated" tax system is, however, open to abuse since it is difficult for the government to tell the difference between someone who will really flee and someone who is bluffing. Hence, the actual system in Denmark uses measures of "energy intensity" (ratio of energy cost to VAT payment, netting out imports and exports) and charges more "energy intensive," VAT-paying entities a lower CO<sub>2</sub> tax rate.
51. While the law provides that profit can be made, subject to the approval of the Electricity Price Committee, in practice only NESAs take advantage of this opportunity.
52. The Price Committee has the power to review the price at which electricity purchased from own generation to ensure that it is economically justifiable
53. Elsam's web site, <http://www.Elsam.dk>
54. Grohnheit, Poul Erik and Olsen, Ole Jess. "Organisation and Regulation of the ESI in Denmark," Risø-I-1208(EN), Risø National Laboratory, Roskilde, December 1997, Section 4.

55. In some other countries, the utilities would have to pay lenders or equity holders for the use of capital. This cost would be recovered through prices charged customers. Since in Denmark the customers are the lenders/equity holders, the price charged for electricity is net of these payments to capital.
56. Danish Energy Agency (1998), *Combined Heat and Power in Denmark*, p. 20.
57. Grohnheit, Poul Erik and Olsen, Ole Jess. "Organisation and Regulation of the ESI in Denmark," Risø-I-1208(EN), Risø National Laboratory, Roskilde, December 1997, Section 5.1.1.
58. NESA Group 1998 Annual Report at <<http://www.nesa.dk/english.htm>> on 26 October 1999, Note 1, p. 32.
59. Act no.375 of 2 June 1999. A number of accompanying measures have also been adopted including the Bill on CO2 Quotas for Electricity Production (Act no.376), the Bill to Amend the Act on Subsidies for Electricity Production (Act no.377), the Bill to Amend the Act on the Utilisation of Renewable Energy Sources (Act no. 378) and the Bill to Amend the Heat Supply Act (Act no. 379).
60. Notes on the Bill submitted to the Folketinget by the Ministry of Environment and Energy.
61. However, there is a significant difference in the vertical structure of the Danish ESI. the dispersed vertical ownership structure of the Danish industry (many small distribution companies are the owners of generation companies) contrast with the more concentrated structure of other Nordic countries in which relatively big generation companies are vertically integrated into distribution.
62. These requirements are justified by environmental considerations that are outside the scope of this report. The report simply acknowledges that they constitute a barrier to entry that can eventually discourage investment. In the current situation of excess generating capacity, this may be a relatively minor issue but in the long run it can be significant.

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